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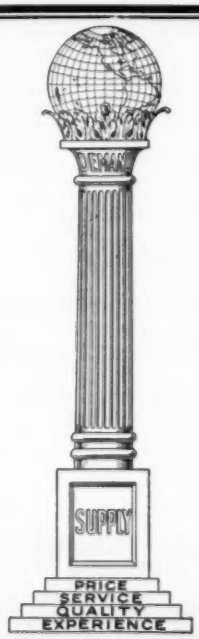

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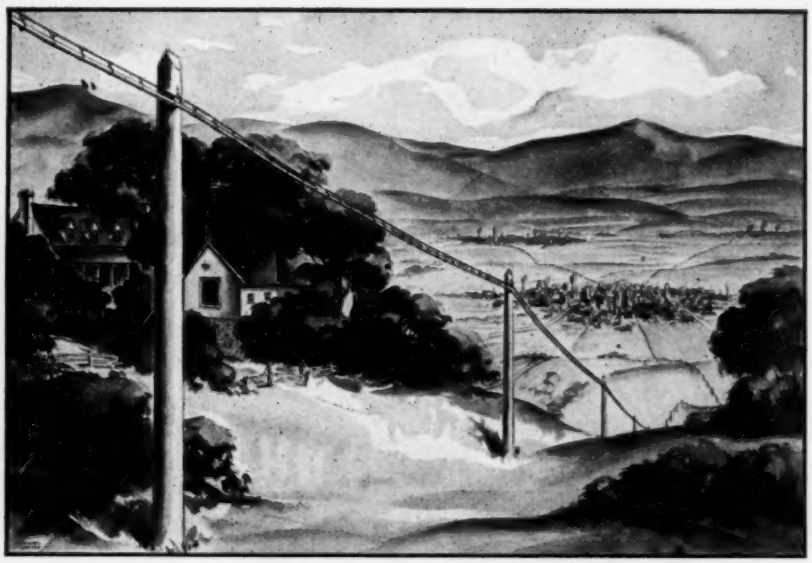

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HARSHAW CHEMICALS

ACID-RESISTING WHITE DRY PROCESS CAST-IRON ENAMELS[1]

By A. I. Andrews

ABSTRACT

Beginning with simple compositions containing only those constituents necessary to make a glass, additions were systematically made in the development and study of acid-resisting enamels.

It was found that the acid resistance depends on the proper combination of constituents rather than the presence or absence of any particular material. It was shown that all fluorine compounds are detrimental to acid resistance but experience shows that some form of fluorine is necessary to obtain good quality opacity. Smelting, if properly done, milling, and firing have practically no effect on the acid resistance.

Acid-Resisting Cast-Iron Enamels

In the cast-iron enameling industry it is highly desirable that the acid-resisting properties of the enamel be improved. The ordinary commercial cast-iron enamels are all severely attacked by such weak acid solutions as lemon juice. Staining is very common due to milk, fruit and vegetable juices, and many city waters. It is due to this lack of resistance that the original bright gloss on cast-iron enamelware is soon worn off. A weak acid solution such as lemon juice will entirely remove the glossy surface on many enamels in less than five minutes. Enamel which has lost its glossy surface has lost one of its most important qualities, that of being easily cleaned. Thus many pieces of ware become yellow or gray, a condition which is entirely caused by solubility and which cannot be removed by any amount of cleaning.

Due to this evident fault in cast-iron enamels and also to the request from the industry for information on the subject, the present research was undertaken. A thorough study of dry process cast-iron enamels was therefore made with the view to the development of acid-resisting cast-iron enamels.

Literature

The literature on acid-resisting enamels is quite plentiful, as this is by no means a new problem. The investigations of this property of enamels have, however, been very specific and the results of one investigation often contradict those of another. This fact is probably due to the great number of variables which enter into this type of work. The kind of test used, the manipulation of the enamel, and the composition are factors, each of which is subject to many variations. It is generally agreed that an increase of silica increases the acid resistance but no other general conclusions can be drawn. A complete review of the literature is available in the following reference.[2]

---

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Enamel Division).

[2] Univ. of Ill., Eng. Expt. Sta., *Bull.*, No. 201.

The Problem

The investigation of the acid-resisting properties of the enamels, as evidenced by the conflicting statements in the literature, is a complicated problem. In this problem it is evident that the manipulation of the enamel is an important factor. The smelting time and temperature, the fineness of grinding, the firing time and temperature, and even the rate of cooling were believed to affect the acid resistance of the enamels.

The composition is undoubtedly of primary importance, yet it alone offers a complicated problem. In the ordinary enamel there may be ten or fifteen different elements furnished by as many or more raw materials.

FIG. 1.—Crucible smelters.

To cope with all possible combinations of this many variables would be almost impossible; therefore, in the present investigation, all possible variables were either eliminated or controlled. It was decided to keep all factors, depending on manipulation, as constant as possible. The composition of the ordinary cast-iron enamel being very complicated, the investigation was started with simple glasses to which additions were made step by step in the study of the properties and the development of good acid-resisting enamels.

Acid Tests

Two tests were used in determining the acid resistance of the enamels investigated. The test to which the most importance was attached was the spot test on the finished enamelware. The other test was the loss in

weight of the frit subjected to constant boiling hydrochloric acid for three hours.

The Spot Test In this test a 7% solution of citric acid was used and this acid solution was placed on the clean finished enamel and left for fifteen minutes. The acid solution was then washed off and the piece examined. A decided attack was designated as "soluble," a slight discoloration was designated as "slightly soluble," and if there was no visible evidence of attack the enamel was considered "acid resisting." In general, an enamel was found to be attacked in fifteen minutes and, in fact, less time than that if attack was going to take place at all. This was found to be a reliable test, especially as it was a simulated service test for the type of enamel being investigated.

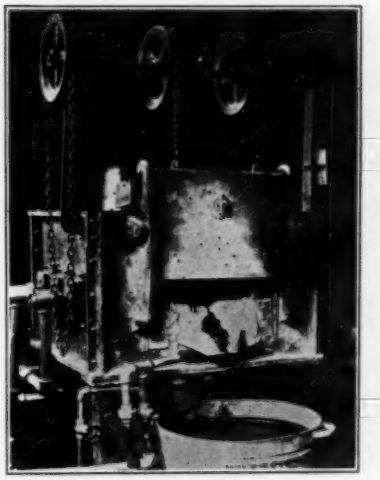

FIG. 2.—50-lb. smelter.

FIG. 3.—Sandblast.

The Grain Solubility Test This test consisted in weighing out five grams of 20- to 40-mesh frit which had been previously washed with alcohol to remove any adhering dust. This grain was introduced into a 100-cc. Erlenmeyer flask and 50 cc. of hot 20% hydrochloric acid were added. It was then kept at 100°C for three hours after which it was immediately filtered through a previously weighed Gooch filter. The loss in weight divided by the original weight multiplied by 100 gives the per cent soluble.

Laboratory Methods

In the laboratory work on this problem it was ever kept in mind that all possible conditions should be controlled and yet the tests and methods should come as near as practicable to those used in the commercial manufacture of enamels.

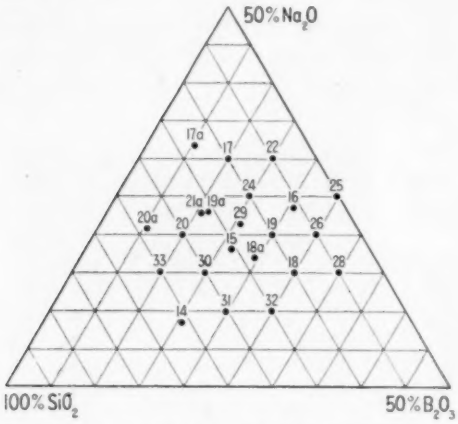

FIG. 4.—Cast iron, Na_2O–B_2O_3–SiO_2.

The method of making up the enamels was similar to the ordinary laboratory practice. Small batches were used (5 lbs.) for the preliminary tests and large batches (50 lbs.) were used to check the more promising compositions. Successful large batches were tried out in plant practice, and if successful there, they were made up on regular plant scale.

The five-pound batches were smelted in crucibles in pot furnaces as shown in Fig. 1 and the 50-pound batches were smelted in the box type gas-fired furnace shown in Fig. 2. A laboratory sand-blast (Fig. 3) was used to clean the iron and a standard grip coat was used in all cases. The enamel was applied by the dusting process and fired down at 1550 to 1700°F in an automatically controlled electric furnace.

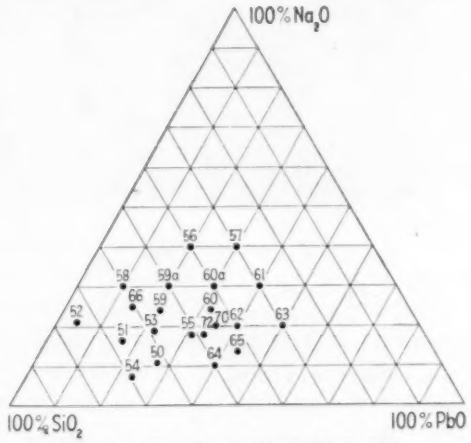

FIG. 5.—Cast iron, Na_2O–PbO–SiO_2.

Fusion Tests Cone fusion tests were made on all simple enamel glass compositions and many of the later enamels. Standard sized cones were made with a 5% dextrin solution, dried, and fired in an especially constructed furnace muffle.[3]

Simple Enamel Glasses

In the preliminary investigation only very simple compositions were studied so as to be able to control the variables as much as possible. Thus

[3] See footnote 2.

an attempt was made to make enamel glasses containing only three oxides, no opacifiers being included. The two 3-component systems studied are the sodium oxide–boric oxide–silica system and the sodium oxide–lead oxide–silica system, each being graphically represented on diagrams, Figs. 4 and 5, respectively. The points on these diagrams represent the compositions actually made in the laboratory, the number over the dot being given to the particular composition for identification.

The Na_2O–B_2O_3–SiO_2 System

The compositions made up in the Na_2O–B_2O_3–SiO_2 system were compounded as follows: Enough of the sodium oxide was added as sodium nitrate to give 5% of sodium nitrate in the raw batch. As much borax as the composition would permit was used to furnish the remaining sodium oxide or boric oxide and the remaining sodium oxide or boric oxide was added as soda ash or boric acid, respectively. The silica was all added as flint.

In all cases the materials were mixed and smelted thoroughly with great care not to drive off appreciable amounts of the more volatile oxides. Checks were made in all cases where there was any question as to the validity of the results obtained and all operations were carefully controlled.

The results of these enamels are shown in Table I and on the diagrams of a paper by the present writer.[4] The percentage loss in weight of the different enamel compositions shows the general trend of the field and in cases of lower silica it is equal to one-half the original weight of the sample. In some cases it appears as though all of the sodium and boric oxides had been dissolved out of the glass.

Under thirty magnifications the attacked grains appear to be not only surface attacked but very badly shattered. In cases where there is appreciable attack the acid solution takes on a yellow color, the intensity of which is apparently proportional to the amount of attack. The yellow color appears almost as soon as the acid is put on the glass grains, which shows that attack is very prompt.

The best enamel glasses of the Na_2O–B_2O_3–SiO_2 system are 15, 18, 18a, 20, 20a, 29, and 30.

Figure 6 shows the cone fusion temperatures of the compositions represented in the above fields.[5] The upper figures represent the temperatures when the cones start to deform and the lower figures represent the temperatures when the cones are down. The general trend of the refractoriness is about what would be expected, increasing with an increase in silica content.

---

[4] *Jour. Amer. Ceram. Soc.*, **12** [6], 390 (1929).

[5] For this figure see A. I. Andrews, "Development of Acid-Resisting White Sheet-Steel Enamels," *Jour. Amer. Ceram. Soc.*, **13** [6], 415 (1930). Figure 5 in this paper shows the same cone fusion temperature results as given for this system.

The Na_2O–PbO–SiO_2 System

The points represented on the Na_2O–PbO–SiO_2 diagram (Fig. 5) were made by adding enough of the sodium oxide as sodium nitrate to furnish 5% of sodium nitrate in the raw batch. The rest of the soda was added as soda ash and the lead oxide was added as red lead. The silica was added as flint. Care was taken in all cases to smelt these compositions thoroughly

TABLE I

SIMPLE CAST-IRON ENAMELS: BORIC OXIDE

	Na_2O	B_2O_3	SiO_2	Temp. (°F)	Acid resist.	Gloss	Opacity	Faults	Cone fusion Start	Cone fusion Down
14	8.5	15.7	75.8	1650						>1700
15	18	16	66	"	1	1	3		1315	1400
16	23	21	56	"	2	1	4		1225	1320
17	30	10	60	"	2	1	4	PC		1200
17a	30	10	60	"	4	3	3	B	1100	1180
18	15	25	60	"	1	1	4		1295	1355
18a	17.5	20	62.5	"	2	1	4		1330	1395
19	20	20	60	"	2	1	4	P		
19a	23	11.4	65.6	"	1	1	3	C	1140	1315
20	20	10	70	"	2	2	3			
20a	21	5.5	73.5	"	1	2	3		1155	1350
21a	22.8	10.7	66.5	"	1	1	4	C	1180	1315
22	30	15	55	"	2	1	4		1070	1230
24	25	15	60	"	2	1	4	C	1155	1275
25	25	25	50	"	4	1	3		1175	1260
26	20	25	55	"	4	1	4		1275	1325
28	15	30	55	"	2	1	3			
29	21	16	63	"	2	1	4		1255	1350
30	15	15	70	"	1	1	3			
31	10	20	70	"	2	1			1325	1380
32	10	25	65	"	2	1	3	C		
33	15	10	75	"		1	3	X	1310	1420
35	22.5	17.5	60	"		1	4			

Excellent = 1
Good = 2
Fair = 3
Poor = 4
Chipped = C

Blistered = B
Crazed = Z
Crawled = X
Many defects = D
Pinholes = P

but not to drive off the more volatile oxides. Checks were made wherever there was any chance for error.

The results of these enamel glasses are shown in Table II and on the diagrams of a paper by the writer.[6] The acid-resistant compositions are 58, 66, 55, 51, 64, and 72. Compositions 53 and 55 lie in a line through the center of the best field, thus making them a good starting point for the development of a good acid-resisting enamel.

The fusibilities of these enamel glasses are shown in Fig. 7, in which cone fusion tests are represented.[7]

The upper figure represents the temperature at which the cone started to

[6] See footnote 4.

[7] For this figure see *Jour. Amer. Ceram. Soc.*, **13** [6], 417 (1930) (Fig. 8).

deform and the lower figure represents the temperature at which the cone was completely down. The general trend of the field is about as would be expected, the silica increasing the refractoriness, the amount depending upon the composition.

TABLE II

SIMPLE CAST-IRON ENAMELS: LEAD OXIDE

	Na_2O	PbO	SiO_2	Acid resist.	Gloss	Opacity	Faults	Cone fusion Start	Cone fusion Down
50	10	30	60	NG	1	2	X	1130	1275
51	16	16	68	1	1	4		1130	1225
52	21	5	74	NG			X	1375	1575
53	19	22	59	1	1	4		1075	1110
54	7	24	69	NG			NG		>1700
55	18	32	50	1	1	4		1025	1075
58	30	10	60	1	3	3	Z	1235	1260
59	24	22	54	2	1	4		985	1060
60	25	32.5	42.5	2	1	3	Z	965	970
62	20	40	40	2	1	3	Z	950	985
64	10	40	50	1	1	2			1215
65	14	43	43	2	1	3			1040
66	25	15	60	1		4		1115	1170
59a	30	20	50	4					
60a	30	30	40	4					
61	30	40	30	4					
56	40	20	40	4					
57	40	30	30	4					
70	20	34	46	2	2	4	Z		
74	16	39	45	2	2	4			
75	13	36	51	1	1	4			
76	17	31	52	2					
72	18	34	48	1	1	3			
63	20	50	30	2					

Excellent = 1
Good = 2
Fair = 3
Poor = 4
Chipped = C

Blistered = B
Crazed = Z
Crawled = X
Many defects = D
Pinholes = P
No good = NG

TABLE III

EFFECT OF FLUXES ON THE ACID RESISTANCE OF THE SIMPLE ENAMEL GLASSES

Enamel	Na_2O	B_2O_3	PbO	SiO_2	Al_2O_3	CaF_2	ZnO	Acid resist.	Gloss	Opacity	Faults
1Z	20.0	15.0		60.0			5.0	2	1	4	
1P	"	"	5.0	"				2	1	4	C
1C	"	"		"		5.0		2	1	4	
1A	"	"		"	5.0			2	2	4	
1PZ	"	"	2.5	"			2.5	2	1	4	
1CZ	"	"		"		2.5	2.5	2	1	4	C
1PC	"	"	2.5	"		2.5		2	1	4	C
1PA	"	"	2.5	"	2.5			2	1	4	C
1CA	"	"		"	2.5	2.5		2	1	4	
1ZA	"	"		"	2.5		2.5	2	1	4	C
1PCZ	"	"	1.7	"		1.7	1.7	2	1	4	C
1PCA	"	"	1.7	"	1.7	1.7		2	1	4	C
1PZA	"	"	1.7	"	1.7		1.7	2	1	4	C
1CZA	"	"		"	1.7	1.7	1.7	2	1	4	

TABLE III (*continued*)

Enamel	Na_2O	B_2O_3	PbO	SiO_2	Al_2O_3	CaF_2	ZnO	Acid resist.	Gloss	Opacity	Faults
3Z	17.5	12.5		65.0			5.0	1	1	4	C
3P	"	"	5.0	"				1	1	4	C
3C	"	"		"		5.0		2	1	4	
3A	"	"		"	5.0			1	1	4	C
3PZ	"	"	2.5	"			2.5	1	1	4	C
3CZ	"	"		"		2.5	2.5	2	1	4	C
3PC	"	"	2.5	"		2.5		2	1	4	
3PA	"	"	2.5	"	2.5			1	1	4	C
3CA	"	"		"	2.5	2.5		1	1	4	C
3ZA	"	"		"	2.5		2.5	1	1	4	C
3PCZ	"	"	1.7	"		1.7	1.7				
3PCA	"	"	1.7	"	1.7	1.7		1	1	4	
3PZA	"	"	1.7	"	1.7		1.7	1	1	4	
3CZA	"	"		"	1.7	1.7	1.7	1	1	4	C
5Z	17.5	12.5		60.0			10.0	1	1	4	C
5P	"	"	10.0	"				1	1	4	C
5C	"	"		"		10.0					
5A	"	"		"	10.0						
5PZ	"	"	5.0	"			5.0	1	1	4	
5CZ	"	"		"		5.0	5.0	2	1	4	
5PC	"	"	5.0	"		5.0		2	1	4	
5PA	"	"	5.0	"	5.0			2	1	4	C
5CA	"	"		"	5.0	5.0		2	1	4	
5ZA	"	"		"	5.0		5.0	1	1	4	
5PCZ	"	"	3.3	"		3.3	3.3	2	1	4	C
5PCA	"	"	3.3	"	3.3	3.3		2	1	4	C
5PZA	"	"	3.3	"	3.3		3.3	1	1	4	
5CZA	"	"		"	3.3	3.3	3.3	2	1	4	
2Z	18.0		22.0	55.0			5.0	1	1	4	
2B	"	5.0	"	"				1	1	4	
2C	"		"	"		5.0		2	1	4	
2A	"		"	"	5.0			1	1	4	
2BZ	"	2.5	"	"			2.5	1	1	4	
2CZ	"		"	"		2.5	2.5	2	1	4	
2BC	"	2.5	"	"		2.5		2	1	4	
2BA	"	2.5	"	"	2.5			1	1	4	
2ZA	"		"	"	2.5		2.5	1	1	3	
2BCZ	"	1.7	"	"		1.7	1.7	2	1	4	
2BCA	"	1.7	"	"	1.7	1.7		1	1	4	
2BZA	"	1.7	"	"	1.7		1.7	1	1	4	
2CZA	"		"	"	1.7	1.7	1.7	2	1	4	
2CA	"		"	"	2.5	2.5		2	1	4	
4Z	18.0		22.0	50.0			10.0	1	1	4	
4B	"	10.0	"	"				2	1	3	
4C	"		"	"		10.0		2	1	4	
4A	"		"	"	10.0			1	1	3	
4BZ	"	5.0	"	"			5.0	2	1	3	
4CZ	"		"	"		5.0	5.0	2	1	4	
4BC	"	5.0	"	"		5.0		2	1	4	
4BA	"	5.0	"	"	5.0			1	1	4	
4CA	"		"	"	5.0	5.0		2	1	4	
4ZA	"		"	"	5.0		5.0	1	1	3	
4BCZ	"	3.3	"	"		3.3	3.3	2	1	4	
4BCA	"	3.3	"	"	3.3	3.3		2	1	4	
4BZA	"	3.3	"	"	3.3		3.3	1	1	4	
4CZA	"		"	"	3.3	3.3	3.3	2	1	4	

Excellent =	1	Poor =	4	Crawled =	X
Good =	2	Chipped =	C	Many defects =	D
Fair =	3	Blistered =	B	Pinholes =	P
		Crazed =	Z		

Effect of Fluxes and Alumina on Acid Resistance of Simple Enamel Glasses

Most enamels contain alumina and also other fluxes than those contained in the simple enamel compositions thus far studied. It was therefore considered desirable to determine the effects of these materials added to the more promising of the simple enamels. This study was made by means of a systematic addition of these materials as illustrated on the diagrams (Figs. 8 to 11). The simple compositions selected for this experiment were No. 15 from the Na_2O–B_2O_3–SiO_2 system and 53 from the Na_2O–PbO–SiO_2 system. The base compositions of these enamels are as follows:

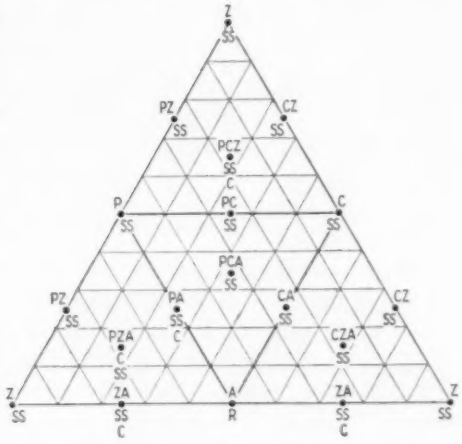

FIG. 8.—Series No. 1, cast iron: Na_2O 20, B_2O_3 15, SiO_2 60; var. 5. SS = slightly soluble. R = acid resistant.

Series	1	2	3	4	5
SiO_2	60.0	55.0	65.0	50.0	60.0
Na_2O	20.0	18.0	17.5	18.0	17.5
B_2O_3	15.0		12.5		12.5
PbO		22.0		22.0	
Variable	5.0	5.0	5.0	10.0	10.0

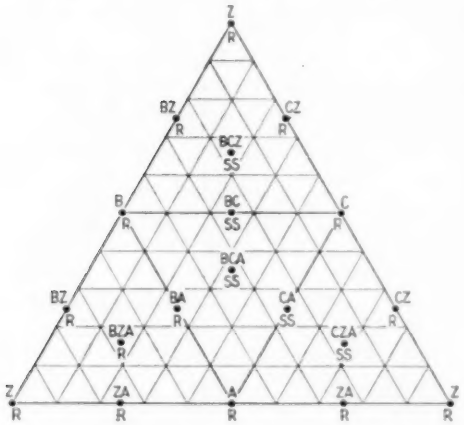

FIG. 9.—Series No. 2, cast iron: Na_2O 18, PbO 22, SiO_2 55; var. 5. SS = slightly soluble. R = acid resistant.

The key to the variables of the compositions is as follows: Z = zinc oxide, P = lead oxide, C = fluorspar, A = alumina.

Combinations of the above letters indicate equal proportions of each oxide involved.

The results and compositions are shown by Table III and Figs. 8 to 11.

Composition 64

Since composition 64 has some opacity, appears fusible enough to melt down on the iron, and is acid resisting, it was modified slightly as

compositions 64Z, 64ZO, 64O, 64C, and 64A (Table IV). In each case of the addition of zinc, zirconium oxide, and alumina, the opacity entirely disappeared and the enamel showed a decided tendency to chip. In the composition with added fluorspar the opacity was weakened and the enamel was not acid resistant. It was found that the opacity of composition 64 and those in the immediate vicinity of this composition in the simple field was due entirely to extremely minute bubbles present in the glass.

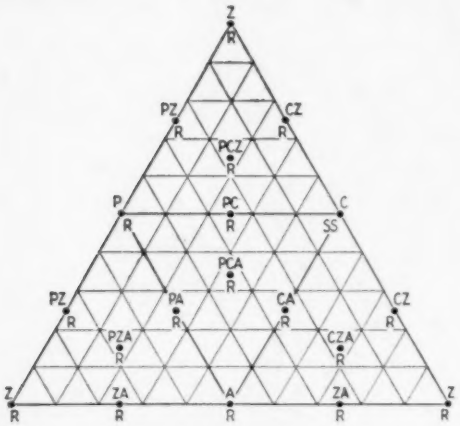

FIG. 10.—Series No. 3, cast iron: Na_2O 17.5, B_2O_3 12.5, SiO_2 65.0; var. 5.0. SS = slightly soluble. R = acid resistant.

Compositions of the 70 Series

The compositions based on No. 64 having shown promise, but no real good enamel, other points in this vicinity of the diagram were investigated. This investigation lead to the 70 series which is based on point 70 shown on Fig. 5.

Table V shows the compositions and the results obtained with each enamel of the 70 series. Those enamels based on point 70 show only slight possibilities, but 71T shows a decided improvement. The enamels based on point 72, however, were decidedly encouraging, composition No. $72T_{15}$ having exceptional properties. This enamel has good opacity and is acid-proof to all of the ordinary fruit or mineral acids. It fires down at 1600°F and is satisfactory except that it must be carefully applied. If applied rough it will stay rough and will not smooth down on firing. Its great resistance to acids, however, makes it valuable and worth considering where this property is desired.

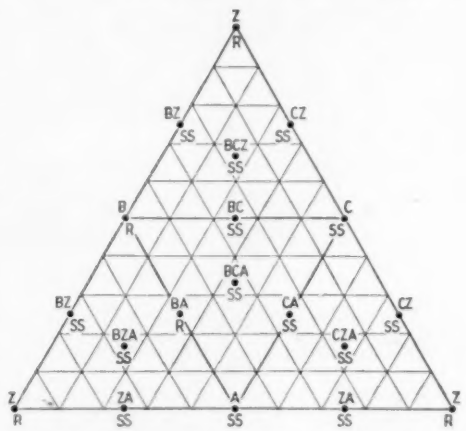

FIG. 11.—Series No. 4, cast iron: Na_2O 18.0, PbO 22.0, SiO_2 50.0; var. 10.0. SS = slightly soluble. R = acid resistant.

TABLE IV

No.	Acid resist.	Gloss	Color	Opac.	Faults	Na_2O	PbO	SiO_2	ZnO	ZrO_2	CaF_2	Al_2O_3
64	1	1	1	3		10	40	50				
64Z	1	1	1	4	C	10	35	50	5			
64ZO	1	1	1	4	C	10	30	50	5	5		
64O	1	1	1	4	C	10	35	50		5		
64C	4	1	1	3		10	35	50			5	
64A	1	1	1	4	C	10	35	50				5

Other compositions such as 74, 75, and 76 with many modifications not shown in this paper did not improve on $72T_{15}$.

Development of Good Acid-Resisting Dry Process Cast-Iron Enamels

The study of the simple enamel compositions and their properties show that acid resistance is not the result of the addition or elimination of any particular oxide or oxides but a proper combination of those present. It is evident that an acid-resisting enamel must run high (50 to 60%) in total refractory oxides (silica, alumina, titania, and opacifier). The sodium oxide must not exceed 20% of the melted weight and is preferably less than this. The fluorspar cryolite and sodium silico-fluoride must not total over 3 or 4% of the melted weight. The amounts of lead and boric oxide may run high if the properties other than acid resistance are not affected.

On the basis of this information many compositions were tried in the laboratory with the object of making good acid-resisting enamels.

The more promising of these enamels are shown in Table VI, some of these compositions being very good enamels. The results show that some of these enamels have good acid resistance, good opacity, gloss, and color with excellent working properties when made up repeatedly in 50-pound batches.

Summary of the General Results and Conclusions

(1) Acid-resisting simple enamels can be made as shown by the composition, $72T_{15}$.

Chemical composition		Batch	
Na_2O	15.6	Soda ash	21.6
PbO	29.6	Sodium nitrate	3.3
SiO_2	41.7	Red lead	26.8
SiO_2	13.1	Flint	36.8
		Tin oxide	11.5
	100.0		100.0

(2) Although $72T_{15}$ is quite refractory, it shows exceptional resistance to acids such as hot, strong hydrochloric, etc.

(3) It is comparatively easy to make simple acid-resistant glazes but difficulty is encountered when good opacity is desired.

(4) Firing temperature does not affect the acid resistance of dry process cast-iron enamels to any great extent.

TABLE V

Enamel	Acid resist.	Gloss	Color	Opacity	Faults	Na_2O	PbO	Al_2O_3	SiO_2	Cryol.	SnO_2	$NaSbO_3$		
70	2	1	1	4	Crazed	20	34		46					
70C	2	1	1	4	Crazed	20	34		46	3				
70T	2	1	1	1		20	34		46		10			
70V	2	1	1	1	Sl C	20	34		46			10		
70TV	2	1	Yellow	1	Sl C	20	34		46		5	5		
71T	1	1	1	2	1	18	35		47		10			
72	2	1	1	4	Crazed	18	34		48					
72T	1	1	1	2		18	34		48		10			
$72T_{15}$	1	1	1	1		18	34		48		15			
$72TC_5$	2	1	1	4		18	34		48	5	10			
$72TC_2$	2	1	1	4		18	34		48	2	10			
$72OC_2$	2	1	1	4		18	34		48	2		$10ZrO_2$		
$72OF_2$	2	1	1	4		18	34		48			$2CaF_2$	$10ZrO_2$	
72L	1	4	1	4	Crazed	18	34		48			$10NaSbO_3$		
72LC	2	1	1	4		18	34		48	2		$10NaSbO_3$		
$72Z_{15}$	2	4	1	4	R	18	34		48			$10NaSbO_3$		
72ZT	2	1	1	1		18	34		48		7.5		$7.5Sb_2O_3$	
72ZL	2	1	1	2		18	34		48			$7.5CaF_2$	$7.5Sb_2O_3$	
72ZO	2	1	1	4		18	34		48			$7.5ZrO_2$	$7.5Sb_2O_3$	
73TLO	1	1	Yellow	1		17	33	2	48		5	$5.0ZrO_2$	$5.0NaSbO_3$	
73ZTL	1	1	Yellow	1		17	33	2	48		5	$5.0Sb_2O_3$	$5.0NaSbO_3$	
73ZTO	1	1	1	2		17	33	2	48		5	$5.0ZrO_2$	$5.0Sb_2O_3$	
$72T_8A_5$	1	1	1	1		18	34	5	48		8			
$72T_8A_2$	1	2	1	1		18	34	2	48		8			
$72T_8A_7$	1	1	1	1		18	34	7	48		8			
$72O_{15}$	2	1	1	1		18	34		48			$15ZrO_2$		
$72T_8A_5TiO_2$	1	1	Yellow	1		18	34	5	48		8			
72ATB	2	1	1	4		18	34	5	48		5	$5TiO_2$	$5B_2O_3$	
72ALB	2	1	1	4		18	34	5	48			$5NaSbO_3$	$5B_2O_3$	
72AOB	2	1	1	4		18	34	5	48			$5ZrO_2$	$5B_2O_3$	
$72TB_5$	1	1	1	3		18	34		48		10		$5B_2O_3$	
74	2	1	1	1		16	39		45					
74A	2	1	1	4		16	39	7	45					
74T	1	1	1	1		16	39		45		10			
74AT						16	39	7	45		8			
74TB	1	1	1	2		16	39		45		10	$5B_2O_3$		
75	1	1	1	4	C	13	36		51					
75T	1	2	1	4	R	13	36		51		10			
75TB	1	1	1	3		13	36		51		10	$5B_2O_3$		
76	1	3	1	4	R	17	31		52					
76T	1	1	1	4	R	17	31		51		10			
76TB	1	1	1	4		17	31		52		10	$5B_2O_3$		

Table VI

Compositions and Properties

U	AR	Gloss	Color	Opacity	Na_2O	B_2O_3	PbO	SiO_2	Al_2O_3	ZnO	BaO	CaO	CaF_2	Sb_2O_3	Cryol.	Na_2SiF_6	TiO_2
U1	1	1	Cream	3	16	6	12	43	3		2			10			8
U2	1	1	"	2	16	8	10	43			5			10			8
U3	1	1	"	2	16	10	8	43			5			10			8
U4	1	1	Gray	2	18	8	8	43			5			10			8
U5	1	1	"	2	20	8	8	43			3			10			8
U6	1	1	1	1	22	8	6	43			1			10			8
U7	1	1	Cream	1	20	10	8	43		6	3		2	8			10
U8	1	1	"	1	20	5	10	40		5			2	8			10
U6a	1	1	Gray	2	22	8	6	43			1			10		1	8
U6b	1	1	"	2	22	8	6	43			1			10		2	8
U6c	1	1	"	1	22	8	6	43			1			10		4	8
U6d	1	1	"	1	22	8	6	43			1			10	ZrO_2	6	8
$U7O_1$	1	1	1	4	20	10	8	43		6			2	6	2		10
$U7O_2$	1	1	1	4	20	10	8	43		6			2	4	4		10
$U7O_3$	2	1	1	4	20	10	8	43		6			2	2	6		10
$U7O_4$	3	1	1	4	20	10	8	43		6			2	0	8		10
U8a	1	1	Cream	1	20	5	10	40		5			2	8		1	10
U8b	1	1	"	1	20	5	10	40		5			2	8		2	10
U8c	1	1	"	1	20	5	10	40		5			2	8		3	10
U8d	1	1	Cream	1	20	5	10	40		5			2	10			10
USb_9	1	1	1	2	15.8	6.9	13.9	46.5	5		3			9.9			
N																	
N1	1	1	1	1	18	10	6	39	2	5		As Whiting 2		10		2	8
N2	1	1	1	1	18	8	8	39	2	5		As Whiting 2		10		2	8
N3	1	1	1	1	18	6	10	39	2	5		As Whiting 2		10		2	8
N4	1	1	1	1	18	4	12	39	2	5		As Whiting 2		10		2	8
N5	1	1	1	1	18	2	14	39	2	5		As Whiting 2		10		2	8
N6	1	1	1	1	18.4	5.1	9.2	38.7	2	6.1		As Whiting 2		10.2		2	8.1
N1a	1	1	1	1	18	10	6	39	2	5		$AsCa_2(PO_4)_2$ 2		10		2	8
N2a	1	1	Cream	1	18	8	8	39	2	5		$AsCa_2(PO_4)_2$ 2		10		2	8
N3a	1	1	"	1	18	6	10	39	2	5		$AsCa_2(PO_4)_2$ 2		10		2	8
N5a	1	1	"	1	18	2	14	39	2	5		$AsCa_2(PO_4)_2$ 2		10		2	8
N6a	2	1	"	1	18	6	9	37	2	6		Wh. 2		10		2	10
M																	
M1	2	1	1	1	16	6	8	40	3	6		2	3	10			6
M2	2	1	1	1	16	8	6	36	4	9		3	2	10			6
M3	3	1	1	1	15	10	4	32	5	12		4	2	10			6
M4	1	1	1	1	16	6	8	40	3	6	2			10	3		6
M5	3	1	1	1	16	8	6	36	4	9	3			10	2		6
M6	3	3	1	1	15	10	4	32	5	12	4			10	2		6
M7	1	3	y	1	16	6	8	40	3	6		2		10			6
M8	1	3	y	1	16	6	8	40	3	6		2		10			8
M9	1	3	y	1	16	6	9	40	3	6		2		10			7
M10	1	1	y	1	16	8	9	40	3	6		2		10			6
M11	1	3	y	1	16	6	8	40	3	6		2	1	10			6
M12	1	1	y	1	16	6	8	40	3	6		2	1	10			8
M13	1	1	y	1	16	6	9	40	3	6		2	1	10			7
M14	2	1	y	1	16	8	9	40	3	6		2	1	10			6
M15	2	1	1	1	16	6	8	40	3	6		2	2	10			6
M16	1	1	1	1	16	6	8	40	3	6		2	2	10			8
M17	1	1	1	1	16	6	9	40	3	6		2	2	10			7
M18	2	1	1	1	16	8	9	40	3	6		2	2				6
M19	1	1	1	1	16	6	8	40		7		2	3	10			8
M20	1	1	1	1	16	6	8	40		9		2	3	8			8
M21	2	1	1	1	16	6	8	40		11		2	3	6			8
M22	1	1	1	1	16	6	8	40	0	6		3		10		3	8
M23	1	1	1	1	16	6	8	40	1	6		2		10		3	8
M24	1	1	1	1	16	6	8	40	2	6		1		10		3	8
M25	1	1	y	1	16	6	8	40	3	6		0		10		3	8
M26	1	3	y	2	17	5	8	40	2	7		0		10		3	8
M27	2	1	y	1	17	5	8	40	3	6		0		10		5	10
M7a	1	1	y	1	16	6	8	40	3	6		2		10		1	6
M7b	1	1	1	1	16	6	8	40	3	6		2		10		2	6
M7c	2	1	1	1	16	6	8	40	3	6		2		10		3	6
M7d	3	1	1	1	16	6	8	40	3	6		2		10		4	6
M7e	1	1	y	1	16	6	8	40	3	6		2	1	10		1	6
M7f	1	1	1	1	16	6	8	40	3	6		2	1	10		2	6

N3a		1	1	"	1	18	6	10	39	2	5			2		10		2	8
N5a		1	1	"	1	18	2	14	39	2	5			2		10		2	8
N6a		2	1	"	1	18	6	9	37	2	6		Wh.	2		10		2	10
M																			
M1		2	1	1	1	16	6	8	40	3	6			2	3	10			6
M2		2	1	1	1	16	8	6	36	4	9			3	2	10			6
M3		3	1	1	1	15	10	4	32	5	12			4	2	10			6
M4		1	1	1	1	16	6	8	40	3	6	2				10	3		6
M5		3	1	1	1	16	8	6	36	4	9	3				10	2		6
M6		3	3	1	1	15	10	4	32	5	12	4				10	2		6
M7		1	3	y	1	16	6	8	40	3	6			2		10			6
M8		1	3	y	1	16	6	8	40	3	6			2		10			8
M9		1	3	y	1	16	6	9	40	3	6			2		10			7
M10		1	1	y	1	16	8	9	40	3	6			2		10			6
M11		1	3	y	1	16	6	8	40	3	6			2	1	10			6
M12		1	1	y	1	16	6	8	40	3	6			2	1	10			8
M13		1	1	y	1	16	6	9	40	3	6			2	1	10			7
M14		2	1	y	1	16	8	9	40	3	6			2	1	10			6
M15		2	1	1	1	16	6	8	40	3	6			2	2	10			6
M16		1	1	1	1	16	6	8	40	3	6			2	2	10			8
M17		1	1	1	1	16	6	9	40	3	6			2	2	10			7
M18		2	1	1	1	16	8	9	40	3	6			2	2				6
M19		1	1	1	1	16	6	8	40		7			2	3	10			8
M20		1	1	1	1	16	6	8	40		9			2	3	8			8
M21		2	1	1	1	16	6	8	40		11			2	3	6			8
M22		1	1	1	1	16	6	8	40	0	6			3		10		3	8
M23		1	1	1	1	16	6	8	40	1	6			2		10		3	8
M24		1	1	1	1	16	6	8	40	2	6			1		10		3	8
M25		1	1	y	1	16	6	8	40	3	6			0		10		3	8
M26		1	3	y	2	17	5	8	40	2	7			0		10		3	8
M27		2	1	y	1	17	5	8	40	3	6			0		10		5	10
M7a		1	1	y	1	16	6	8	40	3	6			2		10		1	6
M7b		1	1	1	1	16	6	8	40	3	6			2		10		2	6
M7c		2	1	1	1	16	6	8	40	3	6			2		10		3	6
M7d		3	1	1	1	16	6	8	40	3	6			2		10		4	6
M7e		1	1	y	1	16	6	8	40	3	6			2	1	10		1	6
M7f		1	1	1	1	16	6	8	40	3	6			2	1	10		2	6
M19A		1	1	1	1	16	6	8	40		7			2	1	10		1	8
M19B		1	1	1	1	16	6	8	40		7			2	1	10		2	8
M19C		1	1	1	1	16	6	8	40					2	1	10		3	8
R																			
R1		4	1	1	1	19.1	8.5	8.5	41.5	2.1	5.3			2.1		6.4		2	8.5
R2		4	1	1	1	20.6	5.2	10.4	41.7		5.2			2.1		6.2		2	10.4
R3	1½% SnO_2 to mill	4	1	1	1	9.6	5.5	9.8	41.5	2.2	6.5			2.2		6.5		2	8.7
R4		4	1	1	1	17.2	6.45	8.6	43	3.2	6.45			2.1		6.2		2	6.4
R5		4	1	1	1	16.8	6.32	8.45	42	3.16	6.32			2.1		6.2		2	8.4
R6		4	1	1	1	17.0	6.38	8.5	42.5		7.43			3.2		6.2		2	8.5
P																			
P1		1	3	Bluish	2	15.8	8.4	8.4	41.7	2.8	5.6				0.9	9.2			7.4
P2 Antimonate		1	1	Creamy	1	15.6	8.3	8.2	41.3	2.8	5.5				1.84	9.2			7.4
P2a Chinese		1	1	1	1	15.6	8.3	8.2	41.3	2.8	5.5				1.84	9.2			7.4

(5) The smelting conditions of dry process cast-iron enamels does not affect the acid resistance so long as the enamel is properly smelted.

(6) Fluorspar, cryolite, and sodium silico-fluoride are detrimental to acid-resisting enamels, but they are generally necessary to get good opacity.

(7) Fluorspar plus cryolite plus sodium silico-fluoride should not exceed 3 or 4% in acid-resisting enamels.

(8) The fluxes, lead oxide plus boric oxide, may amount to as much as 20% of the melted weight in acid-resisting cast-iron enamels but are preferably 15 to 18%.

(9) Lead oxide in amounts of over 10% in antimony enamels tends to produce a yellow color.

(10) The silica plus alumina and titania should amount to about 50% of the melted weight.

(11) Titania can be added in amounts up to 8% replacing silica without reducing the acid resistance. Titania in excess gives a yellow tinge to the enamel.

(12) Alumina does not aid acid resistance but is required in small amounts to give the enamel its other good working qualities.

(13) Opacifiers act as refractories and, in general, do not affect the acid resistance.

(14) The rate of cooling and the fineness of grinding have no effect on the acid resistance of dry process cast-iron enamels.

Acknowledgment The data presented in this paper were obtained in an investigation which was conducted by the Engineering Experiment Station of the University of Illinois, of which M. S. Ketchum, Dean of the College of Engineering, is Director, in coöperation with the Cast Iron Research Bureau. This research was carried out in the Department of Ceramic Engineering of which C. W. Parmelee, Professor of Ceramic Engineering, is the head.

The writer wishes to thank C. W. Parmelee for his helpful suggestions and coöperation in this work. He also wishes to thank W. N. Noble and E. F. McDonald, who so conscientiously aided in the laboratory work and the interpretation of the results. The author also wishes to thank the members of the Cast Iron Research Bureau for their coöperation and personal assistance.

PROGRESS REPORT ON THE EFFECT OF FURNACE GASES ON THE QUALITY OF ENAMELS[1]

By A. I. Andrews and E. A. Hertzell

ABSTRACT

The appearance of sheet-steel enamels fired in atmospheres of nitrogen, carbon dioxide, sulphur dioxide, and Urbana city gas has been determined. A study of the effect of variations in the composition of sheet-steel ground coats and sheet-steel cover coats on their resistance to attack by sulphur gases has been made. Plans for future work on the problem are outlined.

Introduction

The detrimental effect of certain gases on enamels is fully realized, but very little definite information is at the disposal of the enameler. The effect of sulphur gases on glazes has received some attention, and they are universally considered very undesirable as constitutents of the furnace atmosphere. The effect of sulphur on enamels has been discussed by Staley[2] and Poste,[3] and the necessity of maintaining oxidizing conditions in the furnace has been studied by Poste,[4] Grainer,[5] Geisinger,[6] Cooke,[7] and others.

The Investigation

Furnace The work with Urbana city gas and with sulphur gases was conducted in the tube shown in Fig. 1. This tube was supported in the muffle of an electric furnace, the open end projecting $4^1/_2$ inches beyond the outside of the Sil-O-Cel brick used as a seal. The enamel to be fired was placed on the firebrick support by means of a long, narrow fork. The sheet-steel pieces were 20-gage and measured two by four inches. For the other gases, a fused silica tube $^7/_8$ inches in diameter was used. This tube was heated by a small tubular electric furnace. The steel pieces used were 20-gage and measured $^3/_4$ by two inches.

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Enamel Division).

[2] Homer F. Staley, "The Control of the Luster of Enamels," *Jour. Amer. Ceram. Soc.*, **1**, 644–45 (1918).

[3] E. P. Poste, Discussion of "The Control of the Luster of Enamels," *ibid.*, **1**, 646–47 (1918).

[4] E. P. Poste, Discussion of "Manganese in Glass Used as a Decolorizer," *Trans. Amer. Ceram. Soc.*, **19**, 375–77 (1917).

[5] John S. Grainer, "Observations on the Factory Control of Fishscaling," *Jour. Amer. Ceram. Soc.*, **5**, 100 (1922).

[6] E. E. Geisinger, "Microscopic Study of Ground Coat and Cover Coat Enamel Reactions," *ibid.*, **5**, 328 (1922).

[7] R. D. Cooke, "The Effect of Furnace Atmosphere on the Firing of Enamels," *ibid.*, **7**, 277–81 (1924).

Method of Procedure

Control of Atmosphere

The control of the SO_2 atmosphere was somewhat facilitated by the fact that clay bodies absorb sulphur gases at certain temperatures, only to give them off gradually to the surrounding atmosphere. The stoneware tube in which the enamels were fired proved to have this property to a considerable extent. The method used to control the atmosphere consisted in exposing the tube to SO_2 gas at about 1500°F, allowing the tube to cool, and then reheating to the firing temperature of the enamel. The sulphur gases were gradually given off, their per cent in the tube atmosphere decreasing continuously.

Set-Up for Test

The preparation for a test consisted in clearing the gas sampling tube and placing a bottle containing an iodine solution in the line. This solution was prepared by adding 250 cc. of water to 5 cc. of 0.00025 *N* iodine solution colored with starch. The enamel sample was then placed in the furnace, and the gas sample pulled through the iodine solution by means of the suction produced by affording an outlet to the water in the gas collecting bottle. The gas sampling was discontinued just before the piece was removed from the furnace. The water displaced was measured in a graduated cylinder, and the volume thus obtained was considered to be the total volume of the gas sample. Any iodine which was not reduced by the SO_2 was then titrated with a sodium thiosulphate solution of known strength.

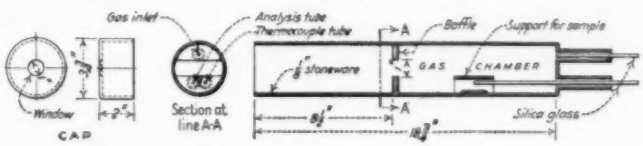

FIG. 1.—Muffle for electric furnace. Scale: 1/4 in. = 1 in.

The end point with solutions as dilute as those used is not very sharp, and to reduce the error in the titration, the sample being determined was compared with a standard which had already been titrated to the end point. From the data obtained, the average PPM[8] by volume of SO_2 present over the firing period was calculated.

For all the other gases the sample for analysis was first collected in the regular two-bottle gas collecting system, and 100 cc. were then transferred to a Hempel burette. The carbon dioxide was absorbed in a KOH solution. The nitrogen was determined by difference. The oxygen in the sample was absorbed in pyrogallol, and the volume of the gas remaining from a 100-cc. sample was read directly as nitrogen.

Effect of Sulphur Gases on Enamels

Within the range of concentrations used the SO_2 had a very distinct

[8] PPM = parts per million.

TABLE I

COMPOSITION OF SHEET-STEEL GROUND COATS

Composition	R1	R22	R29A	R29B	R29C	R29E	R29F	R29H	R29H$_2$	R29H$_4$	R29H$_6$	R82A	R82B	R82C	R82D
Feldspar	31.2	30.7	30	38.4	36.9	35.4	33.5	28.8	28.8	28.8	28.8	25	20	30	40
Flint	20	19.5	20	10.1	9.7	9.3	13.3	16.4	16.4	16.4	16.4	15	30	20	10
Borax	28.5	25.1	30	26.3	25.2	24.2	26.3	26.2	26.2	26.2	26.2	40	30	30	30
Soda ash	9	6.4	7	9.1	8.7	8.4	6.9	4.5	4.5	4.5	4.5	8	8	8	8
Sodium nitrate	4	5.0	5	3.1	2.9	2.8	3.0	3.0	3.0	3.0	3.0	4	4	4	4
Fluorspar	6	7.5	6	7.1	6.8	6.5	7.1	7.1	12	6	0	6	6	6	6
Cryolite							4.1	8.1	3	9	15				
Red lead					4.2	8.									
Cobalt oxide	0.35	0.4	0.5	0.3	0.3	0.28	0.3	0.3	0.3	0.3	0.3	0.5	0.5	0.5	0.5
Manganese dioxide	1	5.0	1.5	0.7	0.7	0.65	0.7	0.7	0.7	0.7	0.7	1.5	1.5	1.5	1.5
Nickel oxide		0.3		0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2				
Barium carbonate				2.0	1.9	1.86	2.0	2.0	2.0	2.0	2.0				
Calcium carbonate				2.0	1.9	1.86	2.0	2.0	2.0	2.0	2.0				
Copper oxide				0.6	0.6	0.56	0.6	0.6	0.6	0.6	0.6				
Mill	Frit, 100 Clay, 7 Borax, 0.3 Water, 45														

effect on the enamels. On the ground coats it took the form of small white pock marks which could not be washed off with water. When a few drops of distilled water were placed on the enamel and allowed to dry, a white scum appeared. In some cases, with higher concentrations of the sulphur gas a scum formed without the addition of water. A solution of this scum gave a test for sulphate.

The sulphur gas had the same effect on white cover coats but it was more difficult to distinguish the marks than in the case of the ground coats. With low percentages of SO_2, the effect took the appearance of a mass of pinholes.

It was interesting to discover that if a ground coat was fired in a sulphur atmosphere, and a cover coat sprayed on it and fired in pure air, the pock mark effect appeared on the white coat.

Since, at the firing temperature the sulphur might be present as SO_2, SO_3, or both, it was necessary to make an analysis to determine the amounts of each gas present. A test conducted by bubbling the gas sample through an iodine solution and an alkali solution containing bromine until

the starch color in the iodine disappeared, and then precipitating with barium chloride solution indicated that the sulphur in the sample was present 97% as SO_2 and 3% as SO_3. It is reasonable to assume that under the same conditions the ratio of these gases present will be approximately the same. In the later work, then, the fact that only SO_2 was determined caused very little difference in the accuracy of the results.

Relation of Composition of Sheet-Steel Ground Coats to Their Resistance to Attack by Sulphur Gases

A total of 15 ground coats covering a wide variation of compositions was studied to determine their resistance to attack by SO_2. The compositions are given in Table I, and the resistance data in Table II.

TABLE II

RESISTANCE OF GROUND COATS TO ATTACK BY SULPHUR GASES

Enamel No.	Lowest concentration of SO_2 at which the enamel is affected (PPM)	Deviation from av. (PPM)	Enamel No.	Lowest concentration of SO_2 at which the enamel is affected (PPM)	Deviation from av. (PPM)
R1	81	20	$R29H_2$	65	4
R22	23	38	$R29H_4$	42	19
R29A	69	8	$R29H_6$	31	30
R29B	45	16	R82A	80	19
R29C	57	4	R82B	64	3
R29E	88	27	R82C	55	6
R29F	64	3	R82D	73	12
R29H	86	25			

The first question that arises is whether the variation in resistance shown in Table II is significant. A study of the data shows that all the enamels are affected by less than 90 PPM of SO_2. If R22 and $R29H_6$ are excluded, the lowest concentration of SO_2 at which the enamels show attack varies from 40 to 90 PPM, giving a range of 50 PPM. The deviation from the average is in all cases less than this. One cc. of 0.00025 *N* iodine solution is equivalent to 0.00279 cc. of SO_2. If the thiosulphate solution is of such strength that 2 cc. of it are equivalent to 1 cc. of the iodine solution, then 1 cc. of the thiosulphate solution is equivalent to 0.00139 cc. of SO_2. The maximum conceivable error in the titration would be 1 cc. of thiosulphate solution. If, then, this error would be obtained in a sample through which 50 cc. of the gas to be analyzed had passed, the PPM error would be 28. In most cases the titration error would be considerably less than this.

A study of the data shows that practically all the determinations fall within the experimental error.

Relation of Composition of Sheet-Steel Cover Coats to Their Resistance to Attack by Sulphur Gases

The work on this phase of the subject was conducted on 18 enamels. The compositions are given in Table III and the data in Table IV and

TABLE III

COMPOSITION OF SHEET-STEEL COVER COATS

Composition	R3	R3A	R3B	R3C	R3E	R57	R57A	R57B	R57C	R57E	R9A	R9C	R9D	R83A	R83B	R83C	R83D	R83E
Feldspar	32	30.7	29.4	34	33	25	23.9	22.9	26.7	25.9	19.3	20.3	19.8	20	20	25	35	30
Flint	18	17.3	16.5	19.1	18.6	21	20	19.2	22.5	21.8	27.7	29.2	28.5	15	25	20	10	25
Borax	25	24	23	26.6	25.8	25.5	24.3	23.3	27.3	26.4	22.9	24.2	23.6	35	25	25	25	15
Soda ash	4	3.8	3.7	4.2	4.1	3.5	3.3	3.2	3.7	3.6	5.8	6.1	6.0	7	7	7	7	7
Sodium nitrate	3	2.9	2.8	3.2	3.1	3.5	3.3	3.2	3.7	3.6				4	4	4	4	4
Fluorspar	4	3.8	3.7	4.2	4.1						6.9	7.2	7.0					
Cryolite	12	11.5	11.0	6.4	9.3	14	13.4	12.9	7.5	10.4	15.6	11	13.4	12	12	12	12	12
Red lead		4.2	8.2				4.1	8.1										
Antimony oxide	2	1.9	1.8	2.1	2.1	3	2.8	2.7	3.2	3.1				6	6	6	6	6
Zinc oxide						5	4.8	4.6	5.4	5.2	1.7	1.8	1.8					

Mill: Frit, 100; Clay, 7; Tin oxide, 7; Magnesium sulphate, 0.3; Water, 45

Figs. 2 and 5. A study of the data reveals the fact that cover enamels differ more widely in their resistance to SO_2 attack than ground coats.

Figure 2 shows the effect of additions of red lead to two cover coats. In the case of R3, the addition of 8.2% of red lead improves the resistance of the enamel considerably. For the R57 series the data obtained in the range studied do not carry any significance, and it will be necessary to study this series at a higher concentration of sulphur gas.

Figure 3 shows that additions of cryolite have very little or no effect on the R3 series or the R9 series. For the R57 series again, a range of higher concentrations of sulphur must be studied.

Figures 4 and 5 give the results for enamels in which the feldspar-borax-flint ratios have been varied. R83E is the outstanding enamel as far as resistance to sulphur attack is concerned, but there is little to choose between in the other four enamels of the series.

To explain the variation in resistance shown by different enamels, a study of their compositions must be made. In the case of R3 and R3B, the two enamels differ only in the fact that R3 is leadless and R3B contains 8.2% of red lead. The increased resistance in this case, then, must be attributed to some property given to the enamel by this amount of lead. It is

interesting to note that R3A, which contains 4.2% of red lead, is no more resistant to attack than R3.

The next explanation must deal with the difference between R3 and R57.

TABLE IV

Enamel No.	Lowest concentration of SO_2 at which the enamel is affected (PPM)	Enamel No.	Lowest concentration of SO_2 at which the enamel is affected (PPM)
R3	10−	R57E	140+
R3A	10−	R9A	55
R3B	140+	R9C	80
R3C	10−	R9D	70
R3E	10−	R83A	100
R57	140+	R83B	70
R57A	140+	R83C	40
R57B	140+	R83D	80
R57C	140+	R83E	140+

A study of their compositions shows only two significant differences in composition. R3 contains 4% fluorspar which is lacking in R57, and R57 contains 5% zinc oxide which is lacking in R3. Thus, it seems either that fluorspar decreases the resistance in the case of R_3 or zinc oxide increases the resistance in the case of R57.

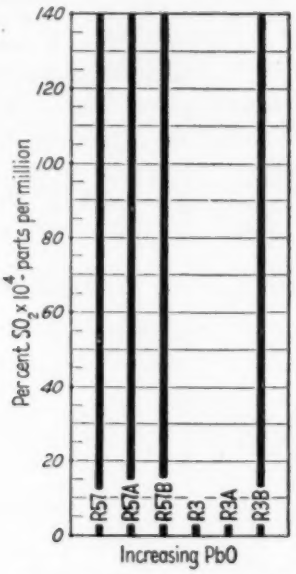

FIG. 2.—Comparative resistance of enamels to attack by SO_2 (cover coat).

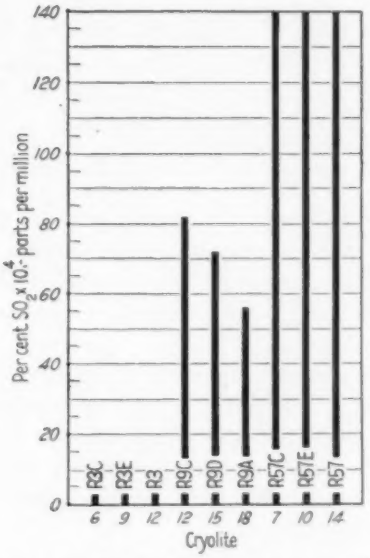

FIG. 3.—Comparative resistance of enamels to attack by SO_2 (cover coat).

The only other enamel investigated which has possibilities as a high sulphur-resisting cover coat is R83E. The reason for this must be associated in some manner with the fact that it contains more flint and less borax than the other enamels of the series.

Future work, then, lies in a more complete study of the enamels which give a high resistance to attack. The specific effect of additions of red lead, zinc oxide, and fluorspar must be further investigated.

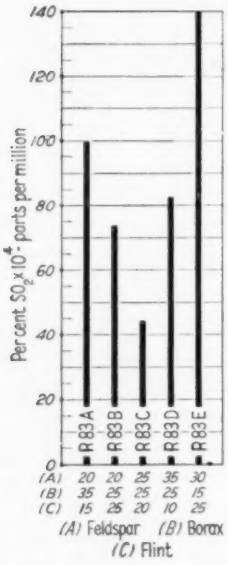

FIG. 4.—Comparative resistance of enamels to attack by SO_2 (cover coat).

Effect of Urbana City Gas on Sheet-Steel Ground Coats

This phase of the work was conducted on ground coats R1, R22, R29A, and R29B. The analysis of the raw gas used is given in Table V.

The gas was first introduced into the rear of the tube at such a rate that combustion took place at the baffle walls shown in Fig. 1. The enamels were fired in the space which was filled with unburned gases. The result was a case of blistering, and at times copperheading, that completely ruined the enamel. Many of the blisters when broken open measured $^1/_2$ mm. in plane diameter.

Then the gas was so adjusted that it burned just on the center of the enameled piece. This time the enamel showed three zones. Large blisters formed where it was exposed to the raw gas, small blisters where combustion took place, and a fairly good surface where it was exposed to the products of combustion.

Finally, the test piece was so placed that the gases were burned before they came in contact with the enameled surface, and under these conditions a good enamel was obtained.

The future work on this phase of the problem obviously lies in determining (1) the lowest per cent of raw city gas which is detrimental to enamels, and (2) which of the constitutents of the gas produce the harmful effects.

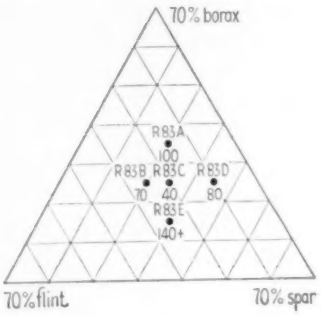

FIG. 5.—Numbers beneath the composition points designate the lowest concentration of SO_2 in parts per million at which the enamel is affected.

Effect of Other Gases on Sheet-Steel Ground Coats

The four sheet-steel ground coats R1, R22, R29A, and R29B were also fired in atmospheres of pure nitrogen and pure carbon dioxide. The result in both cases was the production of a rough surface, probably the blistering

observed by Cooke.[9] The effect, in this case was, by no means, as detrimental as when city gas was used, and without doubt, was caused only

TABLE V

ANALYSIS OF URBANA CITY GAS

Composition	CO_2	Illuminates	O_2	CO	H_2	CH_4	N_2	S
Per cent	4.8	10.4	0.8	21.8	28.1	15.5	18.6	6–9 grains/100 cu. ft.

by a lack of oxygen, whereas, in all probability the city gas and the enamel reacted chemically.

Conclusions

The conclusions of the investigation to date are as follows:

(1) The presence of unburned or partially burned gas and sulphur dioxide in furnace gases is detrimental to the enamels fired therein.

(2) Variations in the composition of sheet-steel ground coats produce little or no variation in their resistance to attack by sulphur gases.

(3) Variations in the composition of sheet-steel cover coats in certain cases produce large variations in their resistance to attack by sulphur gases.

Acknowledgment The data presented in this paper were obtained in an investigation which was conducted by the Engineering Experiment Station of the University of Illinois, of which M. S. Ketchum, Dean of the College of Engineering, is Director, in coöperation with the Utilities Research Commission which represents several utilities companies, chiefly in Chicago, Illinois. This research was carried out in the Department of Ceramic Engineering of which C. W. Parmelee, Professor of Ceramic Engineering, is the head.

It is expected that a detailed report of the research will be published as a bulletin of the Engineering Experiment Station.

The writers wish to thank C. W. Parmelee for his helpful suggestions and coöperation in this research. They wish to also thank O. E. Mulvane and H. W. Alexander, who so conscientiously aided in the laboratory work and the interpretation of the results.

[9] *Loc. cit.*

IMPURITIES IN COMMERCIAL FELDSPARS OFTEN OVERLOOKED BY ENAMELERS[1]

By James R. Crandall

ABSTRACT

The author points out the necessity for careful selection and constant supervision of all raw materials, together with simple tests which the enameler may apply to such materials to insure a uniform product free from objectionable impurities.

Introduction

The paper contains a short résumé of a series of tests made by the writer on a number of feldspars that are being sold to the ceramic industry.

In the average enameling plant of today the raw ceramic materials are bought through a purchasing agent at the lowest market price regardless of the quality of the product. There are some enameling plants, however, that have laboratories and they maintain a careful chemical control of the incoming raw materials. They do not, however, exercise as much control based on the physical characteristics of the materials as is advisable.

The Investigation

Eight feldspars that are being used on a large scale in various enameling plants throughout the country were secured. These feldspars varied in chemical analysis from 13.32 to 9.06% potash and 4.14 to 2.08% soda content.

Small buttons or cone-shaped pellets were made of the feldspars and were fired to about 2500°F. These buttons were examined for traces of impurities, showing as small black or brown specks on the fused surface of the feldspar.

A quantity of the material was washed through a 200-mesh screen and the residue was carefully dried and made into buttons. These were fired at the same temperature as was the feldspar. Some of these residue pellets did not fuse to a nice glossy surface owing to the high percentage of free quartz present; others were dirty and full of black and brown specks.

Samples of these residues were studied under the microscope to ascertain what minerals they contained. The following minerals were found to be associated with the feldspars:

Per cent	A	B	C	D	E	F	G	H
Potash	13.17	10.06	9.98	9.06	13.32	7.19		9.08
Soda	2.08	3.14	3.01	3.06	2.18	4.14		3.02
Microcline								
Plagioclase								
Quartz								
Muscovite							*c*	

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Enamel Division).

Per cent	A	B	C	D	E	F	G	H
Garnet							*b*	
Biotite mica			*a*		*b*	*b*		
Hornblende								
Tourmaline								
Sphene								

a = large amount and large flakes
b = small amount
c = large amount

Feldspars E and F have the least impurities which tend to cause black and brown specks.

Muscovite mica, a potassium aluminium silicate, readily goes into solution; therefore, no trouble is encountered with this material.

Garnet, hornblende, tourmaline, and biotite mica do not go into solution, but maintain their identity throughout the firing treatment.

When these impurities are compounded into an enamel through the medium of raw materials, they come to the surface of the enamel and no matter what amount or type of opacifier is used, these crystalline bodies will show black and brown specks in the finished product.

CROWN CHEMICAL CO.
PITTSBURGH, PA.

COMMERCIAL FELDSPARS PRODUCED IN THE UNITED STATES[1]

By F. P. Knight, Jr.

ABSTRACT

An impartial survey of the various commercial feldspars available is presented to the consumers of that product. Discussions and analyses of many of the commercial feldspars mined in the United States and Canada and analyses of actual shipments are given. The similarities and differences between feldspars of the different sections and the quality and fineness of grinding in connection with the branches of the ceramic industry using feldspar are discussed. Blending of feldspars is also considered.

Introduction

For the past decade there has been a steady increase in the understanding between feldspar consumers and producers. Ten years ago almost no consumer could give specifications and the producer could only send a sample which he hoped would fit the case. The producers were not even in a position to meet exact specifications accurately. Uniformity in most cases ten years ago, was lacking. Fired cones or pats were the criterion and these did not show up the large variations which were somehow being absorbed by the whiteware manufacturers, not without frequent plant trouble.

Consumers manufacturing the same line of ware used feldspars differing widely both in quality and in grinding. Consumers frequently made radical changes in feldspar, one of them changing from a feldspar having 10% free quartz to one of over 30%, with little realization of the difference. He only knew that the one carrying 30% free quartz was a little more refractory and to his liking.

Today the situation is changed. Now a large number of consumers are giving chemical, mineral, and grinding specifications. The producers can meet these specifications with a high degree of accuracy. There are still many consumers who are not giving specifications, but all consumers, whether they are giving definite specifications or not, are profiting by the advance the producers have made, and the consequent fact that more uniform and better feldspar is being supplied today than ever before, and at lower prices. It is unquestionable that these advancements are largely due to the extended use of chemical control by the producers and the consumers.

The producer has accumulated a large amount of data, some of which will be presented here to give the consumers an impartial survey of the commercial feldspars available to them.

The most reliable source of feldspar is not in North Carolina, Maine, New Hampshire, or elsewhere, but the producers at any point who deserve the confidence of their consumers.

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (White Wares Division).

Analysis and Use Distribution

Before considering the feldspar producing sections, a brief survey of the present consumption will give individuals some idea of the relation between the analysis of the feldspar that they use and the average analysis of the total feldspar consumed in this country. The survey will also give them an idea of the distribution of the total tonnage. The average analysis and distribution of total tonnage given in Table I is interesting in connection with the following generalizations covering the different consumers of feldspars.

Electrical Porcelain Electrical porcelain may be divided into two groups, high tension and common. The former is a class, which, as a whole, demands the purest feldspar of any group. They want low free quartz content (less than 5%), high potash-soda ratio, and low iron and impurities. As in all cases, however, there are exceptions. Some prefer a higher free quartz content, and some use a feldspar of lower potash-soda ratio than others. The requirements of all, however, are strict. For common electrical porcelain, feldspar is purchased more on a price basis and frequently at the expense of quality.

General White Ware The so-called general whiteware requirements are quite variable. As a whole they use a body feldspar of higher free quartz content than the average. A potash-soda ratio of over 2:1 and a good color after firing are almost universally demanded, but beyond these requirements there is distinct individuality.

Many potters still rely wholly on simple fusion tests. Changes from a feldspar of high free quartz content to one of low and vice versa are still made without realization of the difference until adjustments have to be made to fit the new feldspar. The fact that much greater losses are not experienced in such adjustments indicates that general ware manufacturers can absorb considerable variation in their feldspars. The plants, however, that are watching their feldspar shipments closely, are having less plant trouble.

Sanitary Porcelain The needs of the sanitary ware manufacturers are similar to the general ware producers in the variety of their feldspar requirements. The average silica content of feldspar used in sanitary ware is probably higher than any other branch of the whiteware industry. Both sanitary and general ware manufacturers use an average feldspar having a potash-soda ratio of a little less than 3:1. Fired color is even more important to the average sanitary ware than to the average general ware producer.

Tile The floor tile manufacturers use a greater percentage of feldspar in their formulas than any other ceramic industry, and are more particular about what they use than any except the high tension insulator

people. Consequently, their average demand is for a purer feldspar than that represented by the average analysis in Table I*A*, although the difference in any respect from this average is probably small.

Whiteware Glaze The glaze feldspars for all industries are similar in that they are comparatively high in soda. For the most part the potash-soda ratio is not over 1:1, although some want a ratio of 2:1, and a few want even higher ratios. The higher soda glaze feldspars are the most uncertain, and it is with these feldspars that analyses are apt to be misleading, especially if they are not thoroughly understood, both as to themselves and to the minerals they represent. Analyses of the higher soda feldspars will be presented in connection with the states in which they are produced.

Enamel The enamel manufacturers are divided into two groups, one using higher quality feldspars and the other low. The best

TABLE I

A		*B*	
SiO_2	69.2%	White ware	
Al_2O_3	17.6	Electrical porcelain	14.0%
Fe_2O_3	0.1	General	17.0
CaO	0.5	Sanitary	10.0
K_2O	9.1	Tile	12.0
Na_2O	3.2	Enamel	10.0
Loss on ignition	0.3	Glass	32.0
		Abrasive	1.5
		Miscellaneous	3.5

A = estimated average analysis of the total feldspar consumed in the United States at the present time, based on an actual average analysis of over 30,000 tons.
B = estimated distribution of the total feldspar consumed in the United States at the present time, based upon figures from the Feldspar Grinders Institute.

as well as the poorest qualities are used, but the average is probably equal in chemical composition to the average analysis in Table I*A*, with the exception of iron oxide, which would be a little higher. It is in the enamel field that the most decided change in quality of feldspar used has taken place within the last decade.

Most enamelers today are using chemical analyses and insisting upon a high degree of uniformity and good quality.

The major difference from feldspar used in whiteware is in the grinding, which for the enameler averages appreciably coarser, although some enamelers use 200-mesh material, the same as is almost universally used in whiteware. Another difference is that the enameler is more particular about the constancy of the silica content of feldspar, whereas the whiteware producer directs his attention more to the fluxes.

Glass The glass industry, or more particularly the glass container industry, uses about 32% of the total feldspar ground in the United States. Contrary to the understanding of many, glass feldspar

is not always low quality material. In many cases it is equal or better than the feldspar used by many whiteware producers.

Comparative freedom from iron-bearing minerals is demanded by the glass people, with the exception of those making green glass. The average silica content of glass feldspar is probably a little over 1% higher than that in the average analysis in Table I*A*, but glass feldspar is tending toward lower silica and higher alumina.

The requirements for glass feldspar are different from other lines in that alumina is the most important constituent outside of iron. This does not mean that the glass man is not interested in the other constituents, but he does allow wider limits of variation in them.

The grinding for glass feldspar averages much coarser than in any other case, by far the greater tonnage being 20-mesh material having a residue on a 200-mesh screen of over 40%, as against the pottery feldspar residue of less than 1%.

Abrasive The abrasive trade for the most part specifies a potash feldspar with 20 to 25% of free quartz. Rarely is a soda content of over 3% desired.

Terra Cotta The terra cotta people as a whole want comparatively low fusing feldspar for use in their glazes.

Non-Ceramic There are several miscellaneous industries outside of the ceramic field which use feldspar, the most important of which is the scouring soap industry, which, in many cases, uses a high grade feldspar. Other miscellaneous uses for feldspar are for roofing, concrete aggregates, non-ceramic abrasives, filler, and poultry grit. These non-ceramic items consume an estimated 3.5% of the total feldspar production.

Variability of Commercial Feldspars Considered by States

All feldspar mines are operated in pegmatite deposits. All pegmatites contain quartz, mica, and iron-bearing minerals, together with at least three different feldspar-minerals, in varying proportions. Practically any state producing feldspar can produce the highest and lowest qualities, although in different states, different types predominate, and high quality, low silica feldspar is more available in some states than in others.

North Carolina North Carolina shipped its first carload of crude feldspar in 1911. Until 1914 all feldspar was shipped out of the state in crude form, mainly to New Jersey and Ohio mills. In 1914, a grinding plant was built at Erwin, Tenn., a short distance from the heart of the North Carolina producing section. In 1917, North Carolina took the lead in the production of crude feldspar, and today it supplies nearly 50% of the total consumed in this country. There are

now five grinding plants in the state, and one operating at Erwin, Tenn. These plants grind nearly all of the North Carolina feldspar produced.

Table II contains analyses of North Carolina commercial feldspars. Analyses A, B, and C are averages of several hundred tons of each of three grades of feldspar selected, during the same period of time, from a sorting belt carrying run-of-mine material from one mine only. Every pound of these three grades of feldspar passed through an automatic sampler. Every sample so taken was analyzed and the analyses of them were used in calculating the averages given here.

When a mine (called one of the best in the state by J. L. Stuckey, former state geologist), yields several hundred tons of material known to be as

TABLE II

NORTH CAROLINA FELDSPAR

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Ignition Loss	Total
A	66.60	18.63	0.10	0.45	Tr	11.32	2.73	0.21	100.04
B	68.19	18.02	0.11	0.58	Tr	9.65	3.26	0.28	100.09
C	71.75	16.88	0.14	1.09	Tr	4.87	5.13	0.26	100.12
D	66.83	19.13	0.10	0.81	Tr	8.43	4.38	0.33	100.01
E	66.90	18.94	0.11	0.45	Tr	9.38	3.87	0.19	99.84
F	68.30	18.87	0.13	0.85	Tr	6.62	5.18	0.25	100.20
G	65.93	19.12	0.10	0.18	0.01	12.30	1.55	0.75	99.94
H	66.13	18.38	0.06	0.50	0.04	11.93	2.47	0.31	99.82
I	71.87	17.69	0.14	1.62	Tr	1.54	7.11	0.27	100.24
J	71.50	16.07	0.10	0.34	0.01	9.00	2.40	0.40	99.82
K	73.11	15.06	0.12	0.29	0.05	9.12	1.96	0.12	99.83
L	72.21	16.16	0.10	0.82	Tr	6.93	3.60	0.19	100.01
M	67.42	18.24	0.10	0.26	Tr	11.31	2.45	0.30	100.08
N	68.20	17.94	0.11	0.31	0.03	10.10	3.17	0.13	99.99
O	67.93	18.52	0.10	0.77	Tr	8.98	3.96	0.19	100.45
P	69.59	17.55	0.10	0.52	Tr	9.85	2.39	0.23	100.23
R	69.36	18.13	0.11	0.73	Tr	7.37	4.08	0.20	99.98
S	65.76	18.70	0.10	0.52	0.05	12.30	2.18	0.31	99.92

widely different as analyses A and C, then the contention of many that feldspar from one mine is uniform, is open to question.

The feldspar removed from the run-of-mine material (or total rock blasted from the mine) represents only about 30% of the total; 70% of the total rock mined is waste, and there are many tons of perfectly good quartz lying in North Carolina mine dumps. Nor does this statement apply only to North Carolina; it applies to all fields.

Analyses D, E, and F, in Table II, are of feldspars from the same mine. Analysis D accurately represents 1800 tons. Analyses E and F represent lots of 80 tons handled just 11 days apart. Here it is obvious that whether the producer wants to or not, he has got to blend such feldspars, whether or not they come from the same mine.

Analyses G and H are of lots from the same mine handled one month apart. Analysis G has evidence of some kaolinization, whereas H seems to have worked out of the kaolinized zone in the mine. Analysis I repre-

sents the average of several hundred tons of soda feldspar, all from the same mine.

The remaining analyses are of shipments from the state.

By considering that any mixture of the feldspars represented by these analyses, with quartz added or taken out, can be made, one can get an idea of the variety of feldspars that can be, and are produced in North Carolina to supply the requirements of all lines of industry using feldspar.

New Hampshire New Hampshire was second in feldspar production in 1928, and was probably second in 1929 with a little over 13% of the total. This state jumped into prominence in 1922 and in 1924 it took second place, yielding to Maine for the years 1926 and 1927. There is one grinding plant in the state which operates the largest quarry, shipping part of its crude feldspar to a second mill in New Jersey. The production of other quarries is ground in Maine, New Jersey, and

TABLE III

NEW HAMPSHIRE FELDSPAR

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Ignition loss	Total
A	67.95	17.88	0.07	0.50	0.03	10.34	2.84	0.40	100.01
B	74.09	15.14	0.10	0.45	0.01	6.90	3.17	0.19	100.05
C	70.18	17.21	0.08	0.34	Tr	7.92	4.14	0.34	100.21
D	70.44	17.13	0.13	0.05	Tr	9.53	2.55	0.37	100.20
E	68.30	18.04	0.11	0.58	0.02	9.76	3.14	0.20	100.15
F	74.15	15.54	0.18	0.69	0.06	4.52	4.53	0.21	99.88
G	69.54	17.12	0.09	0.42	Tr	9.45	3.09	0.36	100.07
H	68.21	17.84	0.09	0.64	0.04	10.29	2.58	0.27	99.96
I	66.00	18.80	0.10	0.50	Tr	11.50	2.80	0.30	100.00

Connecticut. The last named grinds the feldspar for scouring soap. Small quantities may be ground in mills outside of these three states.

Table III gives analyses of eight shipments of New Hampshire feldspar. Analysis I is estimated, and is given to show that a grade such as it represents could be supplied. Other estimated analyses could be given, but it is evident from those in the table that various types of feldspar are supplied from New Hampshire. Although Analyses C and F show that higher soda feldspars are available, they do not exist in as great quantities as in the southern states. The output from New Hampshire averages well on the potash side, and the majority of it is consumed in the whiteware industry, although all other ceramic lines are listed among its users.

The yield of marketable feldspars from the average New Hampshire quarry is higher than that from the average in North Carolina by several per cent. This is in part due to the fact that cheaper labor allows North Carolina to operate quarries of lower yield. Furthermore, New Hampshire is a comparatively new field, and although other fine deposits will doubtlessly be found, history shows that time brings about an increased operation of lower yielding mines. It is to be emphasized that a high yield of market-

able feldspar from a quarry does not necessarily mean that higher quality feldspar is produced.

The high potash feldspars of North Carolina can be duplicated in New Hampshire within limits altogether too narrow to bother any consumer, and vice versa. The high soda feldspar of North Carolina is difficult to duplicate in New Hampshire because of the former's higher calcium content. This difference in soda feldspars means that a New Hampshire feldspar composed of blended potash and soda feldspars will probably act a little differently from a blend of North Carolina feldspars having very nearly the same analysis.

Graphic granite (coarse intergrowth of feldspar and quartz) is not yet prominent in New Hampshire production. Since it has for a number of years played a large part in Maine production, it may or may not do so in New Hampshire in time. This graphic granite, or its equivalent, is plentiful in North Carolina.

North Carolina, New Hampshire, and all other states have plenty of impurities. Mica is much more prominent in North Carolina feldspar mines, but is the least harmful of the pegmatite impurities. Garnet is common to both territories and must be removed. Black tourmaline is rare in North Carolina but not infrequent in New Hampshire. It, too, must be removed. Black mica is found in both places and must be thrown out. These iron-bearing impurities often ruin otherwise good feldspar deposits. Some of them get into all shipments of feldspar. The care taken in eliminating them can only be proved by a fired trial.

Chemical analysis does not tell the story when it comes to color. A point here is the effect of translucency upon color. The higher silica feldspars show a better color than the clearest selected specimen of high potash feldspar. Some high potash low silica feldspars, however, are opaque when fired, due to slight, non-iron bearing impurities such as kaolin.

Canada Canadian feldspar has been imported into this country in the crude state for many years. During the first half of 1929, the tonnage was 16,109, which means that Canada last year probably supplied at least 12% of the feldspar ground in the United States. There is no question but that Canada has some of the largest feldspar deposits in America. Some huge deposits are lying idle partly because of the higher iron content of the deep reddish feldspar which predominates, and partly because of inaccessibility. Today, the lighter salmon colored feldspars are not so plentiful as formerly, but the possibilities of finding more are by no means exhausted. Canadian feldspar is ground in New York principally, but some is ground in Ohio, New Jersey, and Maine.

Table IV gives analyses of different shipments of Canadian feldspars. Shipments A, B, and C were reported from the same mine, but although B shows considerable variation from A and C, these last are more typical

of the high grade Canadian feldspar. During 1929, analysis A, with its slightly higher iron, indicative of greater use of the deeper red feldspars, has been more common.

Since Canadian as well as any other pegmatites contain quartz, although more segregated, it is not surprising to find shipments such as B, F, and I of Table IV cropping up.

Shipment G was surprisingly high in soda, and gave increased evidence that diversity is a part of every field and pegmatite as well.

Analyses J, K, L, and M are of shipments of two well-known grades of Canadian feldspar. They are soft firing and if compared with feldspars of similar (not identical) analyses of North Carolina feldspars, the

TABLE IV

CANADIAN FELDSPAR

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Ignition loss	Total
A	65.80	18.30	0.13	0.54	0.18	12.42	2.26	0.35	99.98
B	67.95	18.08	0.07	0.25	0.03	10.42	3.14	0.22	100.16
C	65.46	18.95	0.09	0.31	0.12	12.41	2.71	0.25	100.30
D	66.36	18.73	0.14	0.43	0.07	10.97	2.94	0.34	99.98
E	65.28	19.22	0.12	0.20	0.08	13.07	1.98	0.17	100.12
F	68.77	17.18	0.16	0.95	Tr	9.19	3.46	0.46	100.17
G	65.18	18.93	0.10	0.77	0.01	10.94	4.15	0.26	100.34
H	64.98	19.14	0.13	0.55	Tr	12.85	2.11	0.20	99.96
I	68.10	18.17	0.17	0.43	Tr	10.43	2.32	0.68	100.30
J	69.60	16.73	0.12	0.50	0.01	8.75	4.05	0.29	100.05
K	70.44	16.37	0.13	0.58	0.01	9.32	3.05	0.38	100.28
L	71.06	16.41	0.10	0.68	0.09	7.33	4.07	0.23	99.97
M	74.02	14.68	0.11	0.70	0.10	5.13	4.50	0.55	99.79

arguments against the use of chemical analyses would gain headway if not carefully considered.

These higher soda Canadian feldspars have not only a higher soda-lime ratio which means softer firing, but they are composed of little but feldspar and quartz, with none of the mica that occurs in increased quantities in the soda feldspars of North Carolina. These Canadian feldspars could be put beside similar feldspars from Maine, New Hampshire, and New York with results more nearly alike.

The high potash Canadian feldspars can be duplicated in North Carolina (see Table IIS), and elsewhere, although very close duplication in equal quantity would be difficult and unlikely.

All but a small percentage of the Canadian feldspar is consumed by the whiteware industry.

Maine Maine was fourth in tonnage produced in 1928, and very likely was the same in 1929, with a little less than 10% of the total consumed. Maine is the home of the oldest feldspar mines in the country. There are now five grinding mills in the state. An appreciable

quantity of Maine feldspar is shipped in the crude state to New Jersey mills.

In its earlier days, Maine production was confined to feldspar of low free quartz content, but of late years exploitation of the large quantities of graphic granite in the state has been great, with the consequence that most Maine feldspar shipped today contains a relatively high free quartz content. Table V (Analyses A to I) illustrates this fact.

Maine feldspar is an illustration of the difficulty of applying the term "quality" to feldspar. From an analytical standpoint these high silica feldspars are not high in quality. From the standpoint of fired color they are, due to the fact that Maine producers have probably gone to more expense and care in sorting their feldspars than any others. As for reliability, Maine feldspar has always held a good reputation.

Table V also gives an idea of the diversity of feldspars shipped from

TABLE V

MAINE FELDSPAR

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Ignition loss	Total
A	73.60	15.03	0.11	0.25	Tr	8.23	2.37	0.38	99.97
B	67.82	18.36	0.10	0.27	Tr	10.04	3.03	0.31	99.93
C	71.65	17.26	0.13	0.86	Tr	4.76	5.17	0.28	100.11
D	71.40	16.27	0.10	0.16	0.01	9.33	2.69	0.24	100.20
E	72.70	15.75	0.10	0.75	Tr	7.05	3.72	0.22	100.29
F	72.41	15.52	0.10	0.88	0.01	8.37	2.78	0.19	100.26
G	70.85	16.90	0.11	0.35	Tr	8.09	3.38	0.19	99.87
H	72.03	16.03	0.12	0.22	Tr	9.26	2.56	0.23	100.45
I	74.20	14.92	0.08	0.60	Tr	7.36	3.05	0.25	100.46
J	65.42	19.67	0.11	0.21	Tr	11.28	3.42	0.20	100.31
K	66.36	18.94	0.06	0.65	Tr	10.44	3.22	0.18	99.85
L	65.25	19.75	0.07	0.30	Tr	11.04	3.09	0.29	99.79

Maine. Analyses J, K, and L are from two deposits in northwest Maine which are producing lower silica feldspars, and which are the best quarries operating in the state today. As is the case in all sections, exceptionally fine deposits are uncovered from time to time and some of them yield uniform material over a period of years, but even in them irregularities occur. The graphic granites often are relatively uniform, but pockets of clear feldspar are not rare and could easily cause the difference between A and D in Table V.

The soda feldspars of Maine are comparable to those of New Hampshire in relative amounts, and in their properties. The impurities in Maine pegmatites are also similar to those in New Hampshire, although, being an older field, Maine shows more of them in her deposits. Black mica is very common in Maine, and spoils many thousand tons of pegmatite. As is the case with other sections, Maine has varied types of feldspars, although potash feldspars and graphic granites predominate.

Maine feldspar is shipped almost entirely to the whiteware and abrasive industries.

New York New York has been fifth in feldspar production for several years. In 1928 it produced 5.8% of the total of crude feldspar, of which a large proportion was ground in mills within the state, some, however, going to Trenton mills.

Table VI gives analyses of five shipments of New York feldspar. These analyses cover the field only in part because there is marked diversity in New York state, not only in the feldspar from one quarry, but from quarry to quarry. One producer has access to high soda and high potash feldspar, with or without free quartz. Another has a huge mass of pegmatite which is more of a graphic granite nature. Another producer operates a soda feldspar mine which is probably the most unique deposit of feldspar in the country. The mine is mostly underground, and many tons have

TABLE VI

NEW YORK FELDSPAR

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Ignition loss	Total
A	67.52	18.53	0.12	0.38	Tr	10.28	3.41	0.14	100.38
B	67.15	18.59	0.11	0.36	0.09	10.84	2.79	0.13	100.06
C	74.62	15.30	0.13	0.97	0.10	2.79	5.80	0.30	100.01
D	73.60	15.16	0.16	1.08	Tr	7.04	3.06	0.39	100.49
E	74.83	14.81	0.06	0.47	0.02	3.76	6.07	0.30	100.32

been taken out and sold for glaze purposes. Some clear microcline of rather unique appearance is also encountered in the mine.

New York feldspar is sold for the most part to the glass and enamel industries, although an appreciable quantity of glaze feldspar is shipped from the state.

California California in 1928 took a decided jump in production and not only replaced Connecticut in sixth place, but ran New York a close race by producing 5% of the total consumed.

Connecticut Connecticut is one of the oldest feldspar-producing states. New Hampshire passed it in production in 1922, and New York in 1923. The major part of Connecticut feldspar is ground in New Jersey mills. Of the three grinding plants within the state, the oldest is discontinued.

Table VII contains analyses of three shipments of Connecticut feldspar. Variability is further demonstrated. Analysis B indicates the presence of either soda graphic granite or larger crystals of soda feldspar. The majority of the Connecticut feldspar is, however, of the potash variety. The deposits have points of similarity with others of New England and New York, and some Connecticut feldspar is strikingly like some feldspars of North Carolina. The average analysis of Connecticut feldspar is probably close to that in Table I*A*.

Connecticut feldspar is sold principally to the whiteware industry, although other ceramic industries, especially the enamel, are among its consumers.

South Dakota South Dakota is a comparatively new field which is given seventh place with an estimated production of 2% of the total. The producing mines are in the Black Hills, near Key-

TABLE VII

CONNECTICUT FELDSPAR

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Ignition Loss	Total
A	67.52	18.00	0.07	0.48	Tr	10.35	3.31	0.20	99.93
B	72.87	15.63	0.11	0.38	0.08	7.05	3.52	0.45	100.09
C	69.00	17.43	0.12	0.25	Tr	10.45	2.73	0.30	100.28

stone, and the production is handled by one grinding company. High freight rates to consuming centers prohibited production until 1923.

Table VIII gives two analyses which show the high quality of feldspar which has been shipped to date. The analyses are incomplete in that

TABLE VIII

SOUTH DAKOTA FELDSPAR

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Ignition Loss	Total
A	65.85	19.21	0.04	0.35	Tr	11.35	2.65	0.34	99.79
B	63.49	19.59	0.12	0.37	0.09	12.89	2.13	0.50	99.63

they do not show the phosphorous content which is much higher than in feldspars from other sections.[2]

The potash feldspars predominate in the workable pegmatites, but some soda feldspar is present.

Reports indicate considerable irregularity in the kind and size of the mineral particles within the deposits, so that it is likely that careful selection is necessary to yield the feldspar shipments of low free quartz content for which this section has been known. Here again, time may bring about shipments of higher silica feldspars from this territory, although this in no way signifies that shipments of low silica feldspars are not likely to continue as well as formerly.

The South Dakota feldspars of Table VIII fire to an excellent opaque white. It is possible that the presence of phosphorous minerals has a bearing on the opacity.

South Dakota feldspar is shipped to the whiteware and enamel industries, and possibly others of which the writer does not know.

Virginia Virginia probably occupied eighth place in 1928 with tonnage about the same as that of Arizona, both producing between 1.5 and 2% of the total feldspar consumed. The Virginia field became a factor in 1923, although feldspar has long been known to be present in

[2] See article by F. C. Lincoln, *Eng. Mining Jour.*, **124** [1], 5 (1927).

the state. During the past year a grinding mill has been built in the state, production formerly going to Maryland mills, and some of it probably continuing to do so.

Table IX gives analyses of four shipments of Virginia feldspar, although there is possibility that Analysis D is of a blend of Virginia and Maryland feldspars. But there is little question but soda as well as potash feldspar is available within the state, although perhaps in small commercial quantities at present.

The presence of kaolin is noticeable in many deposits from Pennsylvania south to North Carolina and beyond, and some deposits are so altered to kaolin that this mineral is commercially profitable to mine. The reason why this is not true of the northern deposits, although some kaolinization is evident in the north as well, is attributed by E. S. Bastin,[3] to the fact that "glaciation ice has planed off most of the products of rock decay."

This kaolinization noticeable in Virginia feldspars does not mean inferior quality, because the majority of the feldspar shipped has been quite the

TABLE IX

VIRGINIA FELDSPAR

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Ignition Loss	Total
A	65.58	19.40	0.11	0.40	0.05	12.54	1.20	0.76	100.04
B	66.25	18.72	0.08	0.20	0.01	12.36	2.06	0.41	100.09
C	67.21	18.27	0.13	0.33	Tr	11.47	1.62	0.80	99.83
D	70.85	16.80	0.32	1.12	0.11	6.42	3.81	0.36	99.79

contrary. It does mean increased refractoriness. Analysis B, however, indicates possibility of decline in kaolin content, and, as with all fields, no one can say just what kinds of feldspar are available or will be produced from any section as time goes on. There is diversity in Virginia pegmatites as well as in all others.

Virginia feldspar is used in whiteware, particularly electrical porcelain, enamelware, and glass.

Arizona Arizona probably ran close to eighth place in 1928, and certainly was no lower than ninth, with from 1.5 to 2.0% of the total produced. The feldspar is shipped to California to be ground. Reports indicate the presence of good sized deposits in the vicinity of Kingman.

Maryland Maryland is one of the old producing fields, being second only to Connecticut in 1908. It had dropped, however, to tenth place in 1928 and probably 1929, with about 1% of the total production. This field is now best known for its soda pegmatites, and much of the glaze feldspar for general ware comes from this state.

Table X gives analyses of three shipments. Analysis B shows that

[3] "Geology of the Pegmatites and Associated Rocks of Maine," U. S. Geol. Surv., *Bull.*, No. 445, p. 125.

potash feldspar is available. For some time shipments of Maryland feldspar have been comparatively high in iron, with consequent off color after firing. Part of this is due to the occurrence of hornblende as an iron-bearing impurity. Recent reports indicate that shipments of crude potash

TABLE X

MARYLAND FELDSPAR

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Ignition Loss	Total
A	67.85	19.61	0.19	0.57	0.01	1.22	9.95	0.41	99.81
B	69.83	17.55	0.25	0.67	0.07	8.41	2.65	0.42	99.85
C	70.66	16.80	0.21	1.54	0.06	5.35	4.68	0.53	99.83

feldspar of good color after firing are being made to New Jersey. Maryland feldspar is ground in Ohio as well as in Maryland. It finds its way into all branches of the ceramic industry.

Pennsylvania Pennsylvania was second to Connecticut in 1907 but held eleventh place in 1928 with 0.9% of the total. The writer has only come into contact with low grade feldspar from this field, used by one enameler, and does not feel competent to discuss the available grades. That there has been wide diversification in the pegmatites mined in the past is well known. That shipments of high quality have been made from the state is also well known, but at present they are not common.

From 15 to 20% of Pennsylvania feldspar is consumed by various non-ceramic industries.

Colorado Colorado has produced small quantities of feldspar for several years, most of it being used in electrical porcelain. Table XI gives two analyses of shipments which were ground in the state.

TABLE XI

COLORADO FELDSPAR

	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	Ignition Loss	Total
A	64.90	20.17	0.25	0.66	0.07	10.48	2.84	0.57	99.94
B	64.80	19.93	0.16	0.35	0.03	10.89	3.27	0.32	99.75

Minnesota A grinding plant has recently been put into operation in this state, near the Canadian border and a few shipments are reported to have been made.

Discussion This discussion of the feldspar of the various sections should impress the fact that, although some states can produce a higher proportion of one grade of feldspar than others, yet nearly all of them can produce a diversity of feldspars in some quantity. All sections have to deal with considerable variation in their feldspars, variations which if not controlled would cause trouble. This control is what makes the feldspar business interesting. The extension of chemical control has fully proved its practical value. This is a statement of fact. That it is

not perfect is also true, but anyone handling feldspar knows that its quality has been vastly improved in recent years, and that it is vastly more uniform from shipment to shipment. The majority of those who handle feldspar also know that chemical control has played the major part in bringing this about, although in part indirectly. There are still those who criticize, however, and much is now being said about blended feldspars, which, in the minds of many, are presumed to result only from chemical control.

Blended Feldspars

Some years ago, hand-selected crystals of pure potash feldspar from particular quarries were chemically analyzed. A year or more later other hand-selected specimens from the same quarries were analyzed and found to be similar. Their physical properties were probably also found to be similar. The producers found that such carefully selected, pure potash feldspar ran as uniform as any feldspar they could get. They also found that in many cases similar carefully selected, pure potash feldspars from some other mines ran uniform with that from their own mine. Carefully selected, pure potash feldspar from the same mine does (on the average, for there are exceptions to this) run more uniform than any other commercial feldspar mined. This gave the producer a chance to say that feldspar from the same mine runs uniform, which is only a half-truth, because not all shipments of feldspar contain carefully selected, pure potash feldspar by any means; and feldspar from one mine which is not composed of only such carefully selected feldspar does not run uniform. This statement of only the half-truth gave the inference that a uniform feldspar must come from the same mine, and must not be a blended product of feldspars from different mines.

Carefully selected, high potash feldspar from the same mine is of course available today to those who pay the higher price it commands. Producers using chemical control as well as others are shipping it. But although it is available, it is also unquestionable that much less than 25% of the feldspar shipped from the grinding mills of this country is carefully selected pure potash feldspar, whether from one mine or not. By pure is meant almost no free quartz content or free soda feldspar. Over 75% of the feldspar shipped from the mills contains appreciable free quartz. The mere presence of this free quartz in quantities over 3% means an uncertain mixture, and any uncertain mixture does not make for the desired uniformity. Careful blending with material from another or from the same mine in most cases is beneficial.

If possible, let one try to visualize a shipment containing free quartz. There is a pile of rock. If it is graphic granite it is largely made up of pieces of rock in which the quartz appears among feldspar in about the same way that Egyptian writing appears on a stone tablet. The writing,

however, is large here and small there. Looking more closely at the pile, some free pieces of pure feldspar can be seen, and some of pure quartz. How much feldspar and how much quartz is in the pile can only be guessed at, and the feldspar producer not employing chemical control must be a good guesser.

But there is another pile of rock that looks as if it were mostly clear feldspar. Closer examination reveals the fact that there is some graphic granite and also scattered pieces of pure quartz in it. The guessing becomes more difficult. If one knows the feldspar minerals and makes further search of the pile he may find crystals of pure soda feldspar, or that some of the graphic granite is made up of soda feldspar and quartz, rather than of potash feldspar and quartz. No one can guess the relative quantities of these minerals accurately and producers who have no way of sampling a pile of feldspar before grinding it find it best to keep fairly large stocks on hand, from which they can draw out an average by taking feldspar from different sections of the stock piles; or perhaps take a little more potash feldspar or soda feldspar, to change the average to better suit the particular customer being supplied. This is "blending," although the stock of crude feldspar may be from one mine.

It is, however, unlikely that any producer's stock pile will long continue to be solely from one mine. The biggest feldspar mine in North America is the Richardson Mine in Ontario. The largest estimate of its output that the writer has heard has been 400,000 tons, produced over a long period of years. Feldspar mines that have yielded over 100,000 tons of marketable feldspar are rare. Many small openings are constantly being worked. Few develop into really profitable quarries. All producers carry on development work, and use the feldspar from the small openings they develop. They blend their feldspar, perhaps not for all shipments but certainly far more than half the shipments from most if not all sections are blended.

There are few producers who do not buy feldspar from small miners. It is to their benefit to encourage these small miners, because in many cases they can buy cheaper than they can prospect, develop, and work their own mines. If they can buy and reserve their own mines, they are wise to do so. All North Carolina producers buy extensively, and the same is true of many other sections. This buying can only mean one thing: blending, and blending has been going on for years. Again let it be said, however, that any producer can maintain shipments from one mine, as long as the mine holds out, but since the feldspars in many individual mines are variable, blending is a material aid in maintaining uniformity, and in meeting the diversified requirements of the trade.

Chemical analyses help only a little in guessing the contents of a pile of rock if they are made only after the material is ground for shipment.

Real chemical control means that feldspar is accurately sampled before grinding. That can only be done economically by automatic sampling units involving expensive installation. Then, before grinding, an accurate analysis of an accurate sample is available, and the producers using this method have the option of blending or not. Rarely is it not beneficial, and theory or no theory, it is practical.

Instances of apparent discrepancies in feldspars of similar analyses have been discussed before in this paper. In regard to highly technical points involving very slight differences, they have no practical bearing on the situation, if only for the reason that they apply to differences so small, and the limits within which a producer can hope to hold his material are so wide in comparison, that these highly technical differences are completely overshadowed.

The writer believes that the only real point upon which opponents of blended feldspars can base any argument is in connection with feldspars of higher soda content, because crystals of soda feldspar contain varying calcium contents which have material effect upon its properties; and a blended feldspar in which the soda feldspar contains a high amount of calcium acts quite differently from one where the soda feldspar is low in calcium. These soda-lime feldspar crystals are solid solutions, and extremely variable, but they vary within the same mine. They may vary even in the interlaminated soda feldspar present in crystals of microcline.

This variation in calcium content is more important than is generally known. For instance, a feldspar having a calcium oxide content of over 3% would probably go through an 8 cone firing and come out looking more like kaolin than feldspar, providing the potash content was well below 1%.

With the high potash feldspars, this calcium content is not so important, and such feldspars of nearly identical analyses will act the same to every practical intent and purpose, whether from New Hampshire or North Carolina. This statement will hold true for feldspars with a potash to soda ratio of over 3 to 1 and probably for many of them with ratios of somewhat less than 3 to 1. But it must be understood that the analyses have to be nearly the same, because small differences in analyses are very often indications of kaolinization, mica, or other impurities. Two analyses can have the same identical potash and soda contents and yet the other constituents will clearly show marked differences to one who understands the analyses and their relationship to mineral composition.

Commercial shipments of soda feldspar similar to analysis G in Table IV are small. This analysis may represent a presence of an unusual amount of interlaminated soda feldspar in the crystals of microcline or potash feldspar which were ground, but it is doubtful. Shipments of feldspar analyzing 4% soda probably always contain some blended, pure soda feldspar, which always contains calcium. This blended soda feldspar may or may not

have come from the same mine as the potash feldspar with which it is blended, and in some cases the blending may not be purposely accomplished.

Therefore, it may be said that all feldspars having a potash to soda ratio less than 2.5 to 1, or in most cases of less than 3 to 1, are mixtures of free crystals of both potash and soda feldspars, with the exception of the very high soda feldspars which seldom contain much over 1% of potash. Thus the feldspars of the potash soda ratio of less than 2.5 to 1 are blended to all intents and purposes, and it is only because of variation in the calcium content of these soda feldspars that blending is difficult. This variation in calcium content is best detected and handled by chemical control.

After all discussion pro and con, the real point is that producers have certain feldspars to sell. There are differences in many of them, and although the consumer can turn from one feldspar to another of similar analysis and very often not be able to distinguish any difference, yet he should first test out a trial lot. Small differences in analyses, as said before, may mean much, especially in feldspars from different sections, and anyone not thoroughly familiar with analyses should continue the practice of giving new feldspars a large size trial before using them. Then if the trial lot is satisfactory, he can change with safety if the producer is reliable. The consumer can stop worrying about blended feldspars. He is very liable to get them anyway, for the producer knows more about his problems than anyone else and if he blends feldspars he does so largely for the reason that he can best render satisfaction over a period of years by blending.

Conclusions

Chemical control of feldspars has brought about distinct advancement in feldspar production in the last decade and the enormous variation within and between feldspar deposits has been increasingly removed from actual shipments of feldspar to individual consumers.

The requirements of the consumers are extremely diversified but there is enough diversification in the feldspar deposits of the various producing states to meet requirements for all types. Furthermore, most of the producing sections can meet most requirements with feldspars available within themselves.

Blending of feldspars from different mines is done by practically all grinders of feldspar. With the feldspars having a potash to soda ratio of less than 3 to 1, blending becomes more uncertain, but uncertainty exists in any case with feldspars of this nature so that blending does not necessarily add to it, and is very likely to decrease it.

The value of chemical analyses and chemical control is unquestionable. If difference in potash feldspars of practically identical analyses exists, it is too small, and too technical to be of practical importance because of

inability of the producer to maintain shipments to any such degree of uniformity as exists between such feldspars, wherever they are from. Difference in grinding between two successive shipments would probably cause greater variation in physical properties than would result from difference in mineral occurrence in the components of two such potash feldspars.

The producer's job is to satisfy his customers. He is doing a better job than he ever did. Disregarding cost, the consumer would be wise in buying from the producer who most deserved his confidence, no matter from what section that producer derived his feldspar. Various types and qualities of feldspar are available in all producing sections, and it is an exceptional case where feldspar to satisfy the consumer's requirements is not available in many of them.

OXFORD MINING AND MILLING CO.
WEST PARIS, ME.

FELDSPARS AND THEIR PECULIARITIES AS CERAMIC SOLVENTS[1]

By Arthur S. Watts

ABSTRACT

Data are presented to combat the fallacy that the chemical composition of a feldspar is a definite indication of its behavior as a vitrifying agent in ceramic bodies. A general presentation of data on the pure feldspar types and their constitution and mode of occurrence in commercial deposits is made. The effect of solid solution vs. associated or mixed feldspars on the physical properties of feldspars of similar compositions is outlined and the character of associated quartz and muscovite (white mica) is considered. A proposed basis of classification depending on the fusion behavior of the feldspar in the presence of quartz, kaolin, and ball clay is made.

Introduction

This presentation deals only with the feldspars encountered in ceramics, omitting the many rare mineralogical types.

Principal Types of Feldspar

Potash feldspar–microcline (K_2O–Al_2O_3–$6SiO_2$) = 16.9% K_2O–18.4% Al_2O_3–64.7% SiO_2. The principal constituent of the hard or "body feldspar."

Soda feldspar–albite (Na_2O–Al_2O_3–SiO_2) = 11.8% Na_2O–19.4% Al_2O_3–68.8% SiO_2; the principal constituent of the "glaze" feldspar, and the principal associated mineral in the potash feldspar.

Calcium feldspar–anorthite (CaO–Al_2O_3–$2SiO_2$) = 20.1% CaO–36.6% Al_2O_3–43.3% SiO_2; the chief associated mineral in the soda feldspar and a minor but important associated mineral in the potash feldspar.

Barium feldspar–celsian (BaO–Al_2O_3–$2SiO_2$) = 40.8 % BaO–27.2% Al_2O_3–32.0% SiO_2; an important associated mineral in some potash feldspars.

Constitution of the Feldspar Minerals

These feldspars are rarely found in the pure state because they are formed by crystallization from a magma and each mineral as it separates from the mass tends to carry with it, in solution, a greater or less amount of elements or other minerals, depending on its capacity to dissolve them. As it solidifies, some of the minerals in solution are expelled in part or completely. Even after the mineral becomes rigid, changes in its mineral constitution may occur by expulsion of previously dissolved matter.

H. L. Alling[2] presents among his conclusions the following data:

(3) The feldspars belong to a 5-component system. For most purposes it is necessary to consider only the potash, soda, and lime components. Every specimen of feldspar found in nature contains a certain amount of each of these three components.

(8) All feldspars are solid solutions and mixtures of solid solutions, and therefore do not possess definite chemical compositions. No single chemical formula can be assigned to a single species.

[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (White Wares Division).

[2] "The Mineralography of the Feldspars," *Jour. of Geol.*, p. 290, April-May (1921).

Thus, what has been considered to be pure potash or soda feldspar is really a host or vehicle carrying indefinite amounts of other feldspars. Even though by careful selection and inspection, all of the associated minerals are separated, the parent rock has a very indefinite mineral constitution and therefore indefinite properties.

Mode of Occurrence of Feldspars

Of uncertain composition, feldspars are also uncertain in their mode of occurrence.

Potash Feldspar The high potash feldspars occur in three distinct rock forms: (*a*) pegmatite, a coarse aggregate of potash feldspar, soda feldspar, and quartz with more or less associated minerals, all crystallized into a conglomerate mass; (*b*) graphic granite (corduroy feldspar), a crystalline mass in which the feldspars and quartz are present in a symmetrical arrangement which in rock cross-section resembles a group of Chinese symbols, hence its name. The rock structure and absence of associated minerals other than feldspars and quartz indicate that this has a more uniform mineral constitution than the coarse pegmatite; (*c*) perthite, a laminated feldspathic rock consisting of layers of potash feldspars, separated by potash-soda feldspar layers which are now generally recognized as approaching the eutectic mixture of these two feldspars. Very little free quartz is found in such formations.

Soda Feldspar The high soda feldspar occurs in three rock forms: (*a*) as massive albite, frequently associated with basic rocks and sometimes contaminated with magnesia minerals or ferromagnesium minerals to such a degree that its value as a ceramic material is greatly reduced, if not lost; (*b*) as albite pegmatite, occurring with potash feldspar pegmatite and similar in formation; (*c*) as cleavelandite, a lamellar structure found chiefly in highly mineralized areas. Rarely used as a ceramic material.

Calcium Feldspars The calcium feldspars as such have no value as ceramic materials. They are used only when they occur as associated minerals in potash or soda feldspar deposits. In such deposits they rarely occur as calcium feldspar crystals but generally as soda-calcium feldspar, perhaps andesine, which has a composition indicating 50 to 70% soda feldspar and 30 to 50% calcium feldspar. These soda-calcium feldspars are not mechanical mixtures but are solid solutions in which the two types of feldspar are in mutual solution and the rock has properties proportional to the amount of each feldspar present in its composition.

Associated Minerals

Quartz Quartz is in practically all feldspar deposits. It occurs in three principal forms: (*a*) as coarse particles in pegmatites;

(*b*) as sharply defined crystals in graphic granite; (*c*) as sugar quartz or quartz lenses either along the walls of feldspar deposits or in fissures or cooling cracks within the mass.

The quartz particles in pegmatites are apparently formed from the magma of which the feldspar was originally a part. The quartz in graphic granite was perhaps originally dissolved in the feldspar and was crystallized out as the feldspar crystallized. The sugar quartz or massive quartz was undoubtedly introduced into the mass after the feldspar solidified. Its form of occurrence may, therefore, be of great importance in predicting its solubility in the feldspar under industrial conditions.

Mica Mica is almost invariably found associated with potash feldspar and particularly when the feldspar occurs as pegmatite. Mineralogists say that mica is an alteration product of feldspar. Muscovite (white mica) ($2H_2O$–K_2O–$3Al_2O_3$–$6SiO_2$) = (4.5% H_2O–12% K_2O–37.5% Al_2O_3–45% SiO_2), contains the same elements as potash feldspar plus the water of crystallization. It occurs in all sizes of grain from masses, containing several cubic feet to particles of microscopic size.

Probably sub-microscopic particles of mica exist in pegmatite masses and this suggestion is supported by two facts:

(1) All feldspars show a loss on ignition, indicating the presence of volatile matter, presumably water of crystallization.

(2) All feldspars show an excess of Al_2O_3 over the ratio indicated by the alkalis present. It has been claimed that part of the alkali has been lost by weathering, but if so the many specimens of fresh rock indicate a stable mineral with less than the theoretical amount of alkali.

If feldspar is capable of carrying mica in solution (or as finely interspersed inclusions) this would account for the presence of volatile matter and excess Al_2O_3. At least the composition as revealed by chemical analysis could be transposed into normal minerals with very little residue instead of having from 2.5 to 8% Al_2O_3 to figure as kaolin which is not apparent in the microscopic inspection.

Feldspars of Commerce

The feldspars of commerce are mixtures of various feldspars which individually contain other feldspars, and perhaps other minerals, in solution. The properties of each of the feldspar constituents of the rock mass will be regulated by its mineral constitution. If soda feldspar is practically saturated with relatively pure potash feldspar, the soda feldspar constituent will begin to function as soon as its fusion temperature is approached while any undissolved potash feldspar must be gradually dissolved in the soda feldspar solvent or remain inert until its fusion temperature is approached. This may be many degrees higher.

In porcelain, some particles of feldspar are seen which are completely

dissolved while other particles of optically similar feldspar are apparently unchanged. The soda-potash feldspar layers of perthite have been completely fused while the high potash feldspar layers showed no fusion whatsoever. Similar results are obtained by carefully heating pegmatites in which two types of feldspar are present. The graphic granites rarely show this behavior when heated, which suggests that the graphic granites contain only one feldspar component, although different deposits may vary as to its content of dissolved minerals.

What Chemical Analysis Reveals

Chemical analysis was the first scientific tool employed in attacking ceramic problems and it took many years to prove that two clays may have similar chemical compositions but possess widely different physical and pyrometric properties. Clays are influenced as much by the form in which the elements are combined as by the elements present. The fact that two feldspars possess similar chemical compositions is valuable information provided they are alike in mineralogical constitution, but if they differ in constitution we have the same difficulty as with clays. Furthermore, not only must the same mineral components be present in both feldspars but each in the same amount and they must also be of the same composition or the feldspars will differ in fusing behavior.

Exact duplication is impossible and in most ceramic bodies a reasonable variation is permissible, but the futility of using chemical analysis as the guide in the classification of minerals such as feldspars should be emphasized.

Proposed Basis of Classification for Feldspars

The chemical analysis may be retained if desired as a means of identification and for use in detecting variation in the product from individual deposits, but the industrial value of feldspar must be based on its properties as a solvent or vitrifying agent in ceramic ware and not on its value as a source of some individual chemical element. Its ceramic value or classification should, therefore, be based on its behavior as a solvent or vitrifying agent and its influence on the other constituents of ceramic bodies. The principal constituents of ceramic bodies with which feldspar reacts are free quartz, kaolin, and ball clay. Therefore, the following scheme is proposed for expressing the ceramic value of a feldspar:

(1-a) The temperature of initial distortion of a test specimen of the feldspar.

(1-b) Temperature increase necessary to cause the test specimen to deform to $^1/_4$ its original height.

(2-a and 2-b) Same values as (1-a) and (1-b) for a mixture of 95% feldspar, 5% quartz.

(3-a and 3-b) Same values as (1-a) and (1-b) for a mixture of 90% feldspar, 10% quartz.

(4-a and 4-b) Same values as (1-a) and (1-b) for a mixture of 95% feldspar, 5% kaolin.

(5-a and 5-b) Same values as (1-a) and (1-b) for a mixture of 95% feldspar, 5% ball clay.

(6-a and 6-b) Same values as (1-a) and (1-b) for a mixture of 80% feldspar, 10% quartz, 5% kaolin, 5% ball clay.

The shape of the test specimen and its method of formation, the method of setting the specimen in the furnace and many other details could be agreed on after research. The rate of temperature increase as developed for the standard pyrometric cone could be employed and would thus give values either in cones or degrees centigrade.

Such a plan must be worked out in detail before it could be approved, but if a manufacturer had these values for his feldspar, combined with a report on fineness of grain, he would have workable control data.

Furthermore, all of the above tests could be conducted with a simple laboratory outfit and could be completed in a few hours after receipt of the shipment of feldspar, or could be furnished by the feldspar shipper.

Department of Ceramic Engineering
Ohio State University
Columbus, Ohio

SOME REMARKS AS TO THE FORMATION OF SEEDS AND BUBBLES IN GLASS POTS[1]

By Willi M. Cohn

ABSTRACT

Observations on glass pots in plants, experiments on laboratory pots, and theoretical considerations point to the fact that the occurrence of seeds and bubbles may be prevented by the introduction of porous pot walls or by the introduction of porous fireclay rods or similar objects into the melt. The porosity of the walls must be maintained throughout the entire duration of the melting process.

Introduction

A large amount of solid material and a small amount of viscous liquid constitutes glazed ware in the glost firing. The quantity ratio is just the reverse for a glass melt at a high temperature.

The occurrence of bubbles in glazes can be avoided by the use of either a completely impervious or a completely porous body. Only the effect of an impervious body on the glass melt has been hitherto treated in the glass industry. The other possibility, that is, the effect of a porous body on the glass melt, has now been investigated.

A. Observations and Experiments

Porosity of the Pots of Technology

Freshly manufactured glass pots often give glass of only medium quality in the first casts and only after some time give glass of best quality. After a definite number of melts, however, bubbles or seeds appear in all glasses. This phenomenon appears in many pots after a relatively short time; in other pots only after a relatively long time.

By determining the porosity of pots which had been in use for varying periods of time it was possible to determine that a pot at first possesses small porosity. The porosity then increases until it attains a maximum, and then decreases. Finally, the porosity of the pot becomes equal to zero, that is, it has sintered. When thoroughly sintered it will have especially high bubble and seed content.

Experiments with Glass Pots of Varying Porosity

Experiments[2] with laboratory pots of varying porosity show that the pots from which vesicular glass has been obtained after a short time have been manufactured from a less refractory clay than are the pots in which the bubble formation is observed only after a somewhat longer time. Vitrified pots, in contrast to porous pots, furnish glass containing bubbles.

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[1] Received September, 1928.

[2] W. M. Cohn, "Some Observations on the Effect of Refractory Walls upon the Occurrence of Gas Inclusions in the Glass Melt," *Glastech. Ber.* (1928).

The porosity of the experimental pots is increased by adding finely divided substances such as coal dust, flour, and similar substances to the pot batch. These substances burn out during the heating and leave pores in the refractory material. Experimental melts in pots of varying pore content give a decrease in the amount of bubbles and seeds with increasing pot porosity.

It may also be concluded from these experiments that the amount of bubbles and seeds in glass may be decreased by keeping the pot materials porous during the melting process.

Introduction of Foreign Bodies into the Melt

If a foreign body, for instance, a cold fireclay rod, be introduced into a glass melt for stirring or other purposes, as is known, marked bubble formation develops in the melt. The glass "boils." The same phenomenon may be observed if sand, damp wood, pieces of potato, or similar substances are introduced into a glass melt at a high temperature.

All these foreign bodies contain pores, and it is to be assumed that here also a certain relation must exist between the bubble formation in the melt and the pores.

B. Theoretical Ideas

Gases in the Glass

Gases are continually formed in the melting of glass as the result of chemical reactions. In a melt at high temperature these gases are present either as bubbles or as dissolved molecules in the melt. The bubbles are carried to the surface of the melt by currents of the glass melt in the pots and are there given off; or the bubbles may rise to the surface of the melt in consequence of their small specific gravity and leave the melt at the surface.

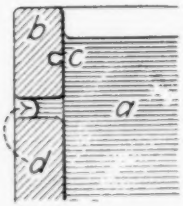

FIG. 1.

Effect of Porous Pot Walls

If the walls of a pot are made of porous material, the following phenomenon is assumed: In Fig. 1 is given a schematic section through a porous pot wall; *a*, represents the melt, *b*, the pot wall, *c*, a pore which is located in the interior of the pot.

A nuclear action will now take place. The molecularly dissolved gases in the melt will enrich themselves at the expense of the air or gas inclusions contained in pore *c*. In this way a larger gas bubble is formed which is finally able to tear loose from the original nucleus and rise to the surface of the melt. A new bubble can then be formed at the nucleus contained in the pore *c*, and the process can begin anew.

An incessant separation of all molecularly dissolved gases is in this way effected in the vicinity of the porous wall. Furthermore, gases will diffuse to this place from the remaining parts of the melt. These gases are then eliminated from the glass in a similar manner.

Another kind of action of the porous body on the melt, which, however, plays only a relatively small rôle, is assumed: Connecting capillaries (canals) are formed in the pot wall from the pores. Such a pore is schematically represented in Fig. 1, *d*. These capillaries will naturally not have the linear course here represented, but will show crooks, ramifications, etc. Liquid glass will penetrate into the capillaries. The attraction exerted by the capillaries as the result of surface tension will not suffice, however, to draw the melt through the entire capillary. It is much more probable that, as the result of the temperature drop in the wall, the viscosity of the infiltrated melt will be decreased to such an extent that penetration of the melt will extend to the full depth of the capillaries.

Escape of the gases from the melt may occur through the surface of the glass in the capillaries just as at the free surface of the melt. The greater the number of ramifications which the capillaries possess and the greater the extent of the free surface thereby formed, the more markedly will be the escape of the gases from the melt. Here also the glass in the vicinity of the walls will be poorer in gas than in the remainder of the melt. Gas diffuses into the parts poor in gas and is given off.

Effect of Porous Foreign Bodies

The formation of bubbles on porous foreign bodies introduced into a glass melt is explained in a way similar to that for porous pot walls. Figure 2 shows a schematic section through a fireclay rod introduced into a glass melt; *a* represents the melt, *b*, the fireclay rod, *c*, a pore which is located at the surface of the rod. On the introduction of the rod into the melt, *c* will represent an air or gas inclusion which cannot disappear after the insertion of the rod. This inclusion now acts as a nucleus for the molecularly dissolved gases in the melt and forms larger bubbles, which finally separate, arrive at the surface of the melt, and are there given off. Fresh bubbles are formed at the nucleus of the fireclay rod.

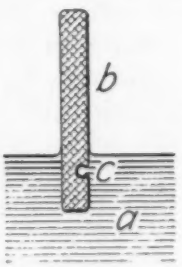

FIG. 2.

Conclusions

All the processes here noted have as their total effect a diminution of the gas content of the melt. The gas escape will continue until all the gas residues are removed from the melt. The formation of macroscopically recognizable seeds and bubbles is then excluded and the manufacture of satisfactory products is assured. Arthur[3] calls attention to the effect of roughened refractory construction materials in the manufacture of satisfactory glass.

The above explanations can also be applied to the phenomena observed

[3] E. P. Arthur, "Large Clay Shapes for the Window Glass Industry," *Jour. Amer. Ceram. Soc.*, **10**, 850–59 (1927).

by Harrison, Saeger, and Krynitzky[4] in enameled ware. They observed the development of bubbles in the enamel layer if unglazed spots occurred on the surface of the iron in contact with the enamel layer. It is not difficult to formulate a theoretical basis for this phenomenon by the assumption of a nuclear action of gas or air residues in this unglazed skin.

Sintered Pot Walls

Sintered pot walls cannot exert the same effect on the gases contained in the melt as do porous walls. Seeds are observed in optical glasses which are melted in pots which have lost their original porosity.

The advantage of a sintered pot wall consists in the fact that the refractory walls cannot be attacked by the infiltration of liquid melts. The melt cannot, therefore, be contaminated by solid particles dissolved from the walls. Complete removal of gas from the melt is, however, not attainable by the use of such sintered materials.

Sintered Stirring Rods

If fireclay rods, used for stirring the melt, are heated to a white glow before insertion into the melt, bubble formation does not result. Bubble formation does result, however, when a cold stirring rod is introduced into the melt. The heated rod has lost its porosity and the nucleus forming action of gas or air inclusions upon the gas in the melt cannot be exerted.

Conclusion

According to our explanations it may be considered to be safely established that, for the removal of all gases from a glass melt, the refractory material must have a certain porosity throughout the entire duration of the melting process. It might, therefore, be advisable to use only such refractory materials for glass pots whose sintering point lies above the highest temperature attainable in glass melting. The materials used must be made non-susceptible to the attack of the melt by suitable composition and pretreatment, so that the solution of small particles from the walls becomes impossible.

The porosity of pots, not naturally porous, must be artificially increased by the addition of finely-divided combustible substances such as coal dust, locomotive clinkers, flour, sawdust, or similar substances which, on heating, burn out of the body and leave porous spaces.

On the contrary, if sintered walls are prepared, the possibility of nuclear action and the gas removal from the melt therewith associated should be provided for by the abundant introduction of porous fireclay rods or other porous objects. The development of manufacturing defects in the form of

[4] W. N. Harrison, C. M. Saeger, Jr., and A. I. Krynitzky, "Progress Report on Cast Iron for Enameling Purposes," *Jour. Amer. Ceram. Soc.*, **11**, 595–608 (1928).

bubbles or seeds in the products might in this way be avoided in many instances.

Summary

From observations on glass pots in operation, from experiments on laboratory pots, and from theoretical considerations, the conclusion is drawn that the occurrence of bubbles and seeds in glass can be avoided by maintaining a definite porosity of the refractory pot walls throughout the entire course of the melting process or by introducing porous refractory materials into the melt. The removal of the gases from the melt is attained by these measures. Gas removal depends upon a nuclear action of the air and gas inclusions in the pores upon the gases in the melt. Furthermore, diffusion of the gases from the melt should be assumed in porous pot walls. This diffusion is effected by the capillaries of the wall. A shortening of the duration of the fining process is also obtained by these measures.

BERLIN-DAHLEM, GERMANY

Discussion

W. M. COHN (addressed to J. T. Littleton): To clear up the particular points in your letter I wish to inform you that:

(1) The kind of glass melts used were soda-lime glass and zinc crown glass which was very difficult to fine.
(2) The temperature of the melts was 1400 to 1450°C.
(3) Time of melting. Partly till the complete fining of the glass in at least one crucible (determined by test gathers) or until the glass in the comparison crucible was nearly completely fined.
(4) Furnace. Gas-fired furnace; at every melting operation four crucibles were inserted, three having variable porosity and one being a normal crucible used as standard capacity of crucibles, 200 g.

Since the conclusion of this work, confirmatory results regarding the porosity of refractories used in the glass industry have been reported. For instance Kanhäuser and Robitschek[1] have found a variation of porosity of materials used for glass pots which is similar to that found in my work; there is also a diminution of porosity with temperature to a minimum and then a partial increase.

For glass tank blocks Endell in his course[2] has stated that the porosity should be from 12 to 25%. MacGee in Table III of his paper[3] gives porosity values of 17.0 to 23.9% for glass tank block refractories.

Before the question of the porosity of refractories used in the glass industry can be pursued any further the fundamental problem of the glass industry must first be solved.

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[1] *Tonind.-Ztg.*, **52**, 1840–52 (1928).
[2] *Glastech. Ber.*, **5**, 602 (1928).
[3] *Jour. Amer. Ceram. Soc.*, **11**, 858 (1928).

Is it expedient to remove all the gas from a glass melt, and to determine whether or not the final product contains definite quantities of gas? It must be definitely determined how the chemical and physical properties of a glass are affected by the occluded gas. When this is known and only then can we say definitely whether or not all the gas must be removed from the melt. Then we can make use of the results given here or find other means of obtaining the end desired.

I should like to point out in conclusion that my observations do not offer any final solution to the problem. They are only to be regarded as a stimulant to any work on this question. No important advance in the question of porosity can be made unless the fundamental problem is taken into account. Finally I wish to say that all opinions expressed in my work are personal and have no relation to the Institute in which I am working.

G. V. McCauley: After reading the enclosed proof of paper by W. M. Cohn, I am inclined to doubt somewhat the so-called observations and experiments on the occurrence of seeds in pots as a function of pot age. Likewise statements regarding the cause of boiling from pieces of wood, refractory, potatoes, and other foreign bodies appear to over-emphasize the rôle played by porosity. Most of this boiling effect, I think, can be attributed to occluded gases and moisture.

The paper does call attention to the method by which dissolved gases in molten glass may escape. The method described is that which is recognized by all who introduce fining agents in the glass. It is recognized that in this process dissolved gases diffuse into bubbles or nuclei formed by foreign gases. The dissolved gases diffuse into these nuclei as into a vacuum until the partial pressure of the diffusing gas in the bubble is equal to the solution pressure of the dissolved gas. The size of the bubble grows with the acquisition of dissolved gas and hence rises through the viscous liquid by virtue of its lower specific gravity than that of the liquid. In the use of fining agents this process is recognized and the attempt is made by their use to introduce nuclei all through the molten mass. It is quite apparent that this would be much more effective than a relatively small number of nuclei furnished by the pores of the pot wall. In this respect I think the author over-emphasized the part played by porosity of the pot walls in clearing glass melts from seed. They no doubt assist in a small measure but must be far less effective than a small amount of fining agent properly selected to yield nuclei for temperatures at which gases are eliminated from the glass batch.

A METHOD FOR DETERMINING THE LOSS OF WEIGHT OF CLAYS DURING FIRING[1]

By W. R. Morgan

ABSTRACT

A simple apparatus has been devised for the comparison of the loss of weight of clays during firing by the direct weighing of the sample while suspended in the furnace. Preliminary results indicate that while the total loss of weight of the different clays varies considerably, the losses in any temperature range expressed in per cent of the total weight lost at 1800°F show a much closer relationship. The comparative ease of control will make it possible to examine the clays under a wide range of conditions.

Introduction

A simple and accurate method was desired for the comparison of the oxidation properties of various clay bodies, and for a study of the phenomena of oxidation itself.

For this purpose an apparatus was devised by means of which the progress of dehydration and oxidation could be determined by the loss of weight of the sample when heated. In this manner it was possible to make a quantitative comparison of results in contrast to the ordinary visual inspection and estimation of the unoxidized area of the sample.

Description of Apparatus

The apparatus consisted essentially of a balance from which a sample could be suspended in an electric furnace below, the temperature of the latter being controlled by a rheostat and wattmeter. The volume of air flowing through the furnace was regulated by a flowmeter and the furnace temperature measured by two base metal couples, one at the top and one at the bottom of the sample, and a potentiometer. The general arrangement is shown in Fig. 1.

The Balance An ordinary two kilogram capacity balance with the arm graduated from one to ten grams in 0.1-gram divisions, sensitive to less than 0.05 gram, was used. The arm and rider were calibrated against standard calibrated weights. The weighings were accurate to the first decimal, the second decimal being estimated.

The Furnace A multiple unit electric furnace wound with chromel wire was used. It had a maximum current capacity of 14 amperes and a maximum safe working temperature of 1800°F.

Furnace Control A simple two plate 14-ampere capacity rheostat was used in conjunction with a 1500-watt capacity watt-

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Heavy Clay Products Division).

meter to control the furnace temperature and duplicate the standard heating schedule which was adopted.

Temperature Measurement Two chromel-alumel couples were made using heavy wire so they could be inserted in the furnace chamber through the bottom of the furnace and be sufficiently rigid to support themselves. One couple was placed in a fixed position at the bottom of the sample, while the other was placed in a position at the top of the sample. Readings were taken by means of a potentiometer reading direct in degrees Fahrenheit having automatic cold-junction compensation.

Air Flow Atmospheric conditions in the furnace were controlled by means of a flowmeter which measured the volume of air passing into the furnace. Air from a pressure line, controlled by a needle valve, passed through the flowmeter, into the furnace at the bottom, up past the sample, and out the top. Fluctuation in line pressure caused some trouble by blowing the liquid out of the flowmeter, but this was overcome by constructing a special flowmeter, with a trap to prevent the liquid from blowing over into the line, and a supply reservoir by means of which the U-tube could be refilled quickly without dismounting the instrument.

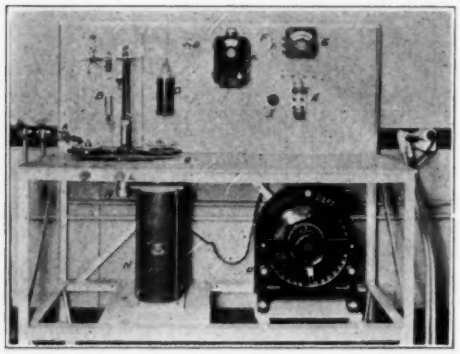

FIG. 1.—*A*—Air connection; *B*—flowmeter; *C*—cold-junction bottle (for use with potentiometer without automatic compensation); *D*—thermocouple switch; *E*—potentiometer; *F*—high and low range switch for wattmeter; *G*—wattmeter; *H*—power switch; *I*—signal light; *L*—quick centering device for balance; *M*—vertical and thrust bearing for balance support; *N*—electric furnace; *O*—rheostat; *P*—balance; *Q*—asbestos cover and insulating pad.

Test Pieces All the test pieces were ground to the same green dimensions, $^3/_4$ by $^3/_4$ by 5 inches, which gave a convenient sample, eliminated variations in sample sizes where bars cut from commercial products were used, and eliminated the effect of surface skin due to the manufacturing process.

Method of Suspension The test piece was suspended by drilling a small hole about one-half inch from one end, at right angles to either pair of parallel faces, through which a short piece of 22-gage chromel wire was passed, extending on each side through the eye of a miniature clevis or bucket bail, also of chromel wire. A connecting link of chromel wire of proper length to lower the test piece into the furnace was hooked through the bail on the sample and the loop on the pan sup-

port of the balance, the balance being mounted above the furnace in such a position that the center of the right hand pan was directly over the vertical axis of the furnace.

Operation After drying for five hours at 110°C and cooling in a desiccator, the test piece was weighed as rapidly as possible and suspended in the furnace, the weights used in weighing being transferred from the first balance to the left hand pan of the second balance, from the right hand pan of which the test piece was suspended. In this manner the gain in weight between the original weighing and the start of the test was not recorded as a loss of weight during the test.

Air was passed through the furnace at a rate of 500 cc. per minute which was approximately eleven times the volume of the test piece.

The average furnace temperature was raised at a rate of 500°F per hour and after a little experience could be held to schedule generally within ± 15°F.

The sample was weighed at the end of each 15-minute period corresponding to a temperature rise of 125°F. Since the sample was suspended from the right hand pan with the rider at the left in zero position, the loss of weight could be read directly simply by balancing the system with the rider as the sample decreased in weight, reading the loss on the beam. The readings thus taken were the cumulative losses in grams at the temperatures at which the readings were taken.

The current was turned off when an average furnace temperature of 1800°F was reached and the furnace and sample permitted to cool.

The weight of the sample when cool was checked against the weight at the end of the test, before removing from the furnace. After removal, the sample was weighed again and the difference in initial and final weight checked against the loss as weighed direct during the test.

TABLE I

CUMULATIVE PER CENT LOSS IN PER CENT OF INITIAL DRY WEIGHT

Temperature (°F)	Sample number 1	2	3	4	5	Mean	Probable error
75							
200							
325	0.06%	0.05%	0.06%	0.08%	0.05%	0.060	0.004
450	0.41	0.11	0.37	0.45	0.56	0.380	0.055
575	1.00	0.51	0.99	1.07	1.02	0.918	0.042
700	1.47	0.96	1.55	1.69	1.47	1.428	0.092
825	1.82	1.47	2.24	2.08	1.86	1.894	0.097
950	2.82	2.61	4.16	3.67	2.71	3.194	0.223
1075	5.47	5.83	7.90	6.72	5.42	6.268	0.349
1200	9.76	10.13	11.00	10.52	9.99	10.280	0.162
1325	11.62	11.55	12.00	11.90	11.74	11.762	0.062
1450	12.29	12.02	12.38	12.37	12.42	12.296	0.054
1575	12.59	12.40	12.62	12.63	12.70	12.588	0.057
1700	12.82	12.63	12.88	12.88	12.99	12.840	0.044
1800	13.05	12.80	13.11	13.10	13.17	13.046	0.048

Typical Results

The results of five tests on five different samples of the same fireclay body are given in Table I as an indication of the accuracy with which tests could be duplicated.

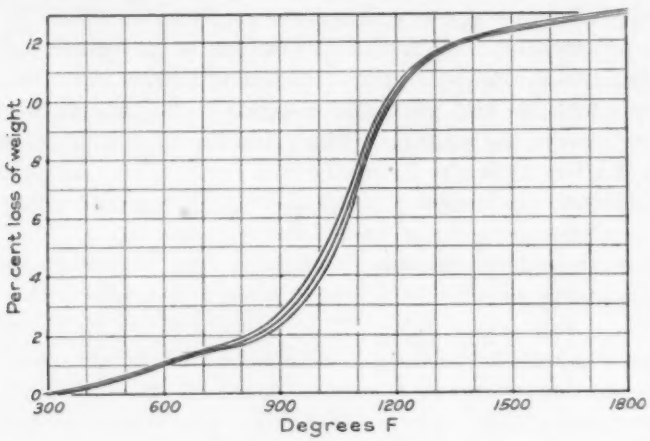

FIG. 2.—Loss of weight in per cent of initial dry weight (110°C). Mean of five samples.

The results are given in Fig. 2, the heavy curve representing the mean value for the five samples and the light curves above and below, the probable error.

While the total loss of weight of different clays and clay bodies varies widely, ranging from approximately 4 to 11%, the losses in per cent of the total weight lost in the different temperature ranges show a much closer relationship.

TABLE II

LOSS IN PER CENT OF TOTAL WEIGHT LOST AT 1800°F

Temperature range (°F)	Mean values for group			Cumulative % for 1 and 2
	1	2	1 and 2	
75– 200	0.17	0.33	0.25	0.25
200– 325	1.32	1.48	1.40	1.65
325– 450	2.57	2.86	2.71	4.36
450– 575	2.56	2.61	2.59	6.95
575– 700	3.55	3.37	3.46	10.41
700– 825	4.97	3.89	4.43	14.84
825– 950	11.53	11.00	11.27	26.11
950–1075	23.34	23.74	23.54	49.65
1075–1200	30.49	27.93	29.21	78.86
1200–1325	10.37	11.60	11.03	89.89
1325–1450	4.40	5.19	4.79	94.60
1450–1575	2.44	2.86	2.65	97.68
1575–1700	1.63	2.13	1.88	99.21
1700–1800	0.66	0.92	0.79	100.00
	100.00	100.00	100.00	

Tests were made on two groups of twenty-two samples each, the mean of each group and mean of both groups being given in Table II.

The values are given graphically in Fig. 3, the continuous curve repre-

senting the cumulative loss at temperatures from 75 to 1800°F in per cent of the total weight lost.

The areas blocked out represent the loss of weight in the temperature range represented by the base of the area, in per cent of the total weight lost. The areas are plotted from the original data. The loss in any temperature range can be determined by subtracting the loss at the lower temperature from the loss at the higher temperature, the values being obtained from the curve representing cumulative losses.

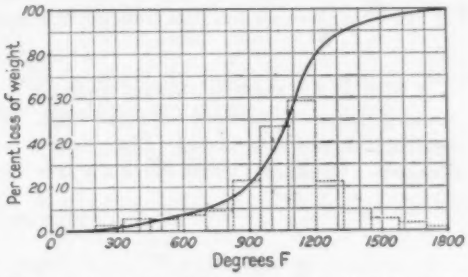

FIG. 3.—Loss of weight in per cent of total weight loss at 1800°F. Mean of forty-four samples.

Tests to determine the effect of the area of the cross-section of the sample on oxidation are in progress. The work planned includes studies of the effects of heating rates, volume of air admitted to the furnace, neutral furnace conditions, reduced pressure, surface skin on the test piece, grog, fineness of grind, porosity, black coring, and such others as may suggest themselves as the work progresses.

Acknowledgment The data presented in this paper were obtained in an investigation which was conducted by the Engineering Experiment Station of the University of Illinois, of which M. S. Ketchum, Dean of the College of Engineering, is Director, in coöperation with the Clay Products Association. This research was carried out in the Department of Ceramic Engineering of which C. W. Parmelee, Professor of Ceramic Engineering is the head.

CLAY SEWERPIPE MANUFACTURE[1]

IX. A Method of Checking Flue-Gas Analyses and Its Application to Ceramic Kilns

By E. A. Hertzell[2]

ABSTRACT

A method for checking flue-gas analyses is discussed and applied to Orsat data obtained during the firing of sewerpipe kilns. Calculations are made for kilns fired by coal, fuel oil, and natural gas. Discrepancies are noted and possible reasons for them advanced. Conditions under which the check applies are presented.

I. Introduction

As will be noted from a study of Paper VI[3] of this series, correct flue-gas analyses are essential for correct heat-balance calculations. The presence of unaccounted for losses of varying and appreciable magnitude emphasizes the necessity of assurance that all possible sources of errors are reduced to a minimum.

The possible sources of error in a flue-gas analysis are from line leaks, incorrect sampling, and faulty solutions in the Orsat apparatus. Despite great care in having the ten or more line joints tight, in collecting the sample for analysis practically continuously at the same rate over the period represented, and in renewing the solutions frequently, the question as to whether the analysis is correct is always present. The method presented in this paper is an attempt to check the Orsat analysis.

II. Theory of the Method

The chemistry of combustion has received considerable attention recently and is probably too well known to make a detailed discussion of it necessary here.[4] It will suffice to state that under the conditions of complete combustion all the hydrogen of the fuel burns to water, and all the carbon to carbon dioxide. If combustion is not complete, however, some of the hydrogen may escape from the stack unburned, while some of the carbon is deposited as soot or burns to carbon monoxide.

Assuming the condition of complete combustion with just enough air to burn all the combustibles in the fuel, a certain definite percentage of carbon dioxide is obtained for a particular fuel. This percentage can be

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Heavy Clay Products Division).

[2] Industrial Fellow, Clay Products Association Industrial Fellowship, Mellon Institute, Pittsburgh, Pa.

[3] R. E. Arnold and George H. Duncombe, Jr., *Jour. Amer. Ceram. Soc.*, **12** [6], 410–22 (1929).

[4] For a complete discussion see Fuels and Their Combustion, by Haslam and Russel, McGraw-Hill.

calculated from the fuel analysis by the ordinary method of calculating the quantity of the products formed by combustion. It represents the maximum percentage of carbon dioxide obtainable from the fuel in question, and will be denoted by CO_{2max}. Under ordinary conditions the flue gas will contain some excess air and the percentage of carbon dioxide present will be less than CO_{2max}.

Bato[5] shows how this CO_{2max} can be used to check the correctness of a flue-gas analysis by means of the following equation:

$$CO_{2max} = \frac{21(CO_2 + CO)}{21 - O_2 + 0.395\ CO}. \qquad (1)$$

The CO_2, CO, and O_2 of the right hand member of the equation are the percentages of these gases in the analysis which is undergoing check. To illustrate the use of the check, it will be assumed that a calculation of CO_{2max} from the fuel analysis gives 18.0 as a result. The flue-gas analysis that is questioned is 14.9% CO_2, 2.3% O_2, and 1.7% CO. By substituting these values in the equation, a balance is obtained with 18.0 on either side, and the gas analysis represents the correct composition of the flue gas.

The question of the sensitivity of this method of checking then arises. To discuss this, the same fuel is assumed and the percentage of each constituent of the gas analysis is changed in turn. In the first instance a change in CO_2 percentage from 14.9 to 13.9 gives a value of 16.9 on the right side of the equation, and to obtain a balance some term, D, must be added. The original equation then becomes

$$CO_{2max} = \frac{21(CO_2 + CO)}{21 - O_2 + 0.395\ CO} + D, \qquad (2)$$

where D is the amount by which CO_{2max} differs from the quantity

$$\frac{21(CO_2 + CO)}{21 - O_2 + 0.395\ CO}.$$

In this case D is the difference between 18.0 and 16.9, or 1.1.

For the second case, assuming an oxygen percentage of 1.3 instead of 2.3, D is calculated to be 0.9. When the CO content is changed from 1.7 to 0.7%, D becomes 0.7.

From this method of calculation it can readily be seen that a change of 1% in any of the constituents of the flue gas will produce a D that will vary according to the gas analysis. From the results of the calculation it can be observed that the method will not detect small errors in the analysis, but will without doubt show the presence of line leaks, spent absorption solutions, or other relatively large errors.

III. Application

For the purpose of this paper, the calculations have been applied to four tests. They include kilns fired by coal, natural gas, and fuel oil. The

[5] Andrew A. Bato, *Mech. Eng.*, **48** [4], 330–36 (1926).

analyses of the fuels used are tabulated in Table I. The results of the calculations are given in Table II.

TABLE I

FUEL ANALYSIS IN PER CENT

A

Test no.	Type	Hydrogen	Carbon	Nitrogen	Oxygen	Sulphur
6	Coal	4.99	71.3	1.30	6.44	5.33
27	Coal	4.92	74.76	1.46	6.17	0.84
34	Fuel oil	11.92	86.76	0.13	0.60	0.59

B

Test no.	Type	Methane	Ethane	Carbon dioxide	Oxygen	Olefins	Nitrogen
31	Natural gas	82.4	10.6	0.8	0.7	0.1	5.3

TABLE II[6]

CO_2 by Orsat (%)	Dead bottom average D[7] for test 6, CO_{2max} = 18.3	Slant grate average D[7] for test 27, CO_{2max} = 18.5	Natural gas average D[7] for test 31, CO_{2max} = 11.9	Fuel oil average D[7] for test 34, CO_{2max} = 15.8
0– 1	6.5	5.2	−3.9	2.8
1– 2	3.8	−1.0	−4.9	0.3
2– 3	2.6	−0.7	−5.0	0.3
3– 4	2.6	−0.6	−4.4	−0.1
4– 5	2.6	−0.5	−1.0	1.0
5– 6	2.1	−0.1	−2.0	0.0
6– 7	1.6	−0.6	−1.3	0.2
7– 8	1.8	0.6	−1.1	0.6
8– 9	1.7	0.5	−0.8	0.1
9–10	1.4	1.5	−0.8	0.1
10–11	1.2	0.4		0.2
11–12	0.9	0.2		0.6
12–13	1.0	0.7		0.1
13–14	1.3	0.6		0.3
14–15	0.9	1.0		0.1
15–16	0.8	1.1		
16–17	0.2	1.1		

[6] Test 34 was calculated for each analysis as it was obtained; the other tests given were calculated recently.

[7] $(-D)$ indicates that the average value of $\frac{21(CO_2 + CO)}{21 - O_2 + 0.395\ CO}$ over the range indicated is greater than CO_{2max}.

IV. Discussion of Results

In discussing the results given in Table II it must be kept in mind that the equation was originally intended as a check on boiler flue-gas analyses in which the CO_2 content was at least 6%. There is no doubt that combustion conditions during the firing of a periodic kiln differ from the conditions obtained in a boiler furnace. One of the most important considerations to be discussed is the effect of gases escaping unburned and undetected by the Orsat. Under conditions of low temperature or low excess air it is possible

for hydrogen to escape unchanged. The first condition is always met during the early stages of the firing and the second is often present at the higher temperatures. Thus in the discussion of results that do not check, it is necessary to consider two cases, either (1) the gas analysis is incorrect or (2) some unburned gases are escaping undetected.

For Test 6 we have the case in which D is positive throughout the firing. One small source of error is found in the fact that considerable carbon remains mixed with the ashes and unburned in the case of a dead bottom box. A recalculation of CO_{2max} gives on this basis a value of 18.1, which gives each D a value 0.2 less than the result tabulated. This correction, of course, does not account for the large values of D shown in the table. If these are due to incorrect gas analyses it means either that not all the CO_2 was absorbed and that the O_2 was increased a corresponding amount, or that a considerable amount of CO was escaping undetected. An actual analysis of 14.9% CO_2, 3.1% O_2, and 0.1% CO, gives a D of 0.8. If all the O_2 is considered to be CO_2, D has a value of 0.4. If CO is increased to 1.1%, D has a value 0.4. In a case of this sort the process of sampling and of analysis should be carefully checked and all solutions should be changed.

For test 27, D is negative for the early stages of the firing and positive for the later periods. In most cases it is considerably smaller than for Test 6, thus indicating better combustion conditions. In the case of incorrect gas analysis the negative results would be due to a high value for O_2. This would indicate a leak in the sampling line, but since the log of the firing shows that no such leak was discovered and since D becomes positive when 7% CO_2 is attained, this does not seem likely. The positive D again would mean a low value for CO_2 or CO. The firing was oxidizing throughout and undetected CO does not account for the discrepancy. Also it does not seem possible that any considerable CO_2 would consistently escape absorption in each of the large number of analyses represented.

On the other hand, the escape of hydrogen or a carbon gas high in hydrogen would account for the negative values of D. The low temperatures of the early stages of the firing favor the escape of these gases.

For Test 31, the values of D are all negative, indicating either a high value for O_2 in the analysis or the escape of unburned hydrogen gases. From the data available it is difficult to give either explanation a preponderance of weight.

For Test 34, the results are uniformly good. This, in general, proved to be true for all the oil-fired tests.

It is to be noted that in all cases D approaches zero as the CO_2 content of the flue gas increases, probably indicating more complete combustion. On this basis it seems quite likely that much of the unaccounted for loss in the early stages of the heat balances is due to unburned gases escaping.

It is advisable, then, in any work of this nature, to have complete analyses of the flue gases, including hydrogen and methane, over certain periods of time. These analyses together with Equation 2 should then give a positive check on the accuracy of the flue-gas analysis.

V. Conclusion

The suggested method of checking flue-gas analyses is of value in detecting faulty sampling, spent solutions, or other sources of appreciable error, provided that no hydrogen-containing gases are escaping unburned and undetected.

Acknowledgment The Fellow wishes to acknowledge the coöperation of the Clay Products Association of Chicago, Ill., and of Mellon Institute of Industrial Research in obtaining the data for the paper. He also wishes to acknowledge the assistance of G. H. Duncombe, Jr., Ceramic Engineer for the Clay Products Association.

CLAY SEWERPIPE MANUFACTURE[1]

X. Measurement of Moisture Loss in Kilns

By Robert L. Blessing[2]

ABSTRACT

This paper continues the description[3] of the methods employed in a survey of sewerpipe kilns.

Data and curves are given to indicate the rates of moisture removal during the normal watersmoking period and at higher temperatures. The information obtained reveals conditions that cause both continuous and non-continuous losses; it is, therefore, difficult to judge the end of the watersmoking period by loss-of-weight methods. The applications of the findings to making heat-balance determinations and to correct kiln manipulation are considered. The discussion covers also the variation and significance of moisture in ware, a possible explanation of weight loss at temperatures above watersmoking, and the danger of using fast rates in this range.

I. Introduction

(1) Historical This is one of a series of papers presenting subjects deemed of general interest which were covered in the extensive kiln investigation conducted by Mellon Institute of Industrial Research.

During this investigation considerable effort was expended on tests to determine the rate at which moisture is given up during the early stages in the firing process, in order that control methods could be developed.

The watersmoking period is often the seat of serious firing difficulties. Hence this period is one of the most important in the firing of good quality ware and offers considerable opportunity for investigation.

(2) Purpose of Paper It is the purpose of this paper to present the experiences and to report some of the data and deductions that resulted from attempting to use loss-of-weight methods in determining the completion of watersmoking or in ascertaining when it was safe to increase the rate of heating.

(3) Methods Attempted In measuring moisture loss it is desirable to obtain measurements that represent average results and to eliminate localized variations that might be developed by differences in distribution of draft through the location of various openings in the under-floor flue system, commonly known as the paving course openings. Owing to the existing differences in this under-floor flue system it seemed advisable to make moisture-loss determinations from test pieces suspended just above the center of the flue in the main flue to the stack

[1] Presented at the Annual Meeting of the American Ceramic Society, Toronto, Ont., February, 1930 (Heavy Clay Products Division).

[2] Industrial Fellow, Mellon Institute of Industrial Research, Pittsburgh, Pa.

[3] R. E. Arnold and George H. Duncombe, Jr., *Jour. Amer. Ceram. Soc.*, **12** [6], 410, 423 (1929); C. E. Parmelee, *Ibid.*, **12** [6] 429 (1929).

near the back draft opening. The pieces were suspended with heavy iron wire from a scale sensitive to 0.05 ounce.

This method proved unsatisfactory because of the large lag between this point and the ware and from top to bottom in the setting. The use of a watersmoking fan, which is sometimes installed at the backdraft, also makes this method impractical. The scale was not sensitive enough to give accurate weighings and the use of iron wire made it impossible to observe weight loss at higher temperatures.

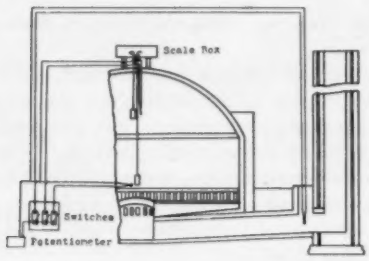

FIG. 1.—Diagram showing location of equipment.

In further tests the pieces were suspended by number 18-gage chromel wire from a balance sensitive to one-tenth gram. This balance was supported on brick pillars above the crown hole through which the wires extended into the kiln. One piece hung on a level with the top of the ware setting and the other approximately a foot from the floor. (See Fig. 1.)

II. Equipment and Method of Procedure

(4) Description of Apparatus The equipment used consisted of a beam scale, sensitive to one-tenth gram, mounted in a covered box which was protected from the hot gases escaping out of the crown hole by galvanized-iron sheeting on the sides and bottom. A V-shaped stirrup with hook was attached to the pan of the scale from which the pieces were suspended alternately for weighing. Hooks on the side of the box held the pieces between weighings.

The clay pieces were a portion of the socket and barrel of the largest size pipe set, 24-inch double strength, and weighed approximately 10 pounds. A third piece was taken for immediate moisture determination in the laboratory oven. Experiment indicated that pieces containing an average amount of moisture gave satisfactory curves.

Temperatures at the suspended pieces were obtained by long, bare chromel-alumel thermocouples with small tube insulators on each wire to protect them from shorting. The wires were extended down through the crown hole to the level of the bottom suspended piece. For heat-balance calculations a similar thermocouple was suspended in the main flue to the stack at the backdraft.

All thermocouples were extended with compensating lead wire to an insulated cold junction box that was kept constant at 32°F by cracked ice.

A Leeds and Northrup portable potentiometer calibrated in millivolts was used to read the temperatures of the thermocouples.

Data sheets were made for hourly readings of weight loss, per cent loss, and temperatures.

(5) Operation Early in the kiln investigation the method used to obtain the total weight in pounds of dry pipe set was to take the weight of an average number of each size to be set after they were supposedly dry on the drying floor. All moisture, however, was not driven off in this type of drier and weights were found to be in error.

The method finally used was to weigh at least 10 pieces of each size pipe set, marking them and reweighing the same pipe after firing. During the setting, a raw clay sample was secured and sent to the laboratory for ignition loss. From the data, the dry weight and total moisture content in the ware set was calculated.[4]

At the start of the test initial weights were taken of the pieces before and after being hung on the wires and all weight-loss readings were subtracted from the original weight of the piece. In taking weight readings a standard technique had to be developed to eliminate errors such as could be caused by the swinging or pendulum action of the suspended pieces; from wind blowing on the scale beam; from dirt or moisture on the scale; and from the order in which the pieces were weighed. Especial effort was made to obtain temperature readings while the weighings were being procured.

(6) Calculations Attention should first be given to the moisture loss data in Table I, which were figured in terms of per cent loss on the dry basis. The average loss in the kiln was taken as the average of top and bottom hourly percentage loss.

The dry weight and total pounds of water to be removed were found as follows:

$$\frac{\text{Weight of ware fired} \times 100}{100 - \%\text{ ignition loss}} = \text{weight of dry ware}$$

For example: Table II, Test 8, gives weight of fired ware as 151,288 pounds and ignition loss of 8.2%.

Then $$\frac{151{,}288 \times 100}{100 - 8.2} = 164{,}802 \text{ lbs. weight of dry ware}$$

Weight of ware as set = 169,145
Weight of ware dry = 164,802

4343 lbs. of water to be removed or 2.64% on the dry basis.

The percentage loss when the weighings showed that the ware was dry was divided into the total weight of water in the ware at the start. From the data in Table I or Fig. 2 for Test 8, the drying of the top suspended piece ended near the twenty-ninth hour, or 4.08%, and the bottom piece near the thirty-fifth hour, or 4.34%, or an average of 4.21%.

$$4343/4.21 = 1032$$

[4] Arnold and Duncombe, *Jour. Amer. Ceram. Soc.*, **12** [6], 416 (1929).

This figure gave the amount of moisture in the ware for each per cent of water in the weighed pieces.

For heat-balance calculations the amount of heat required to evaporate moisture from the ware was considered to be a function of the total weight of water present; temperature of the water when set; and the discharge temperature at the base of the stack.

When considering the heat contained in the moisture in the flue gases it is essential to know the rate of removal, the initial temperature of the ware at the start of the kiln, and the temperature of the flue gases in the main flue at the base of the stack. The heat loss (H) in B.t.u. was found then by

H = weight of water removed in pounds × difference in heat capacity[5] of water at the initial ware temperature and of steam at temperature of gases leaving at the stack.

For this calculation Table III is made using data from Test 8. Columns 4, 5, and 6 fulfil the above equation and the sum of this calculation for each hour over the entire moisture-loss period gives the total B.t.u.'s necessary to remove the moisture from the ware. For Test 8 this total was 5.65 million B.t.u., representing 0.67 % of the total heat input or 448 pounds of 12,629 B.t.u. coal.

III. Data

(7) Tables The following tables, in addition to supplying information for the preceding calculations, are given as typical of the data obtained from the twenty-six tests that were made.

TABLE I

WATERSMOKING MOISTURE-LOSS DATA

Test 8—Kiln 31—Plant 49

	Top			Bottom			
No. of hrs.	Temp. of gases center °F	Moisture loss dry basis (%)	Loss per hour (%)	Temp. of gases center bottom	Moisture loss dry basis (%)	Loss per hour (%)	Temp. of gases at main flue
		0.13	0.13		0.02	0.02	
4	110	0.19	0.06	58	0.02		97
5	124	0.38	0.19	54	0.02	0.04	97
6	133	0.49	0.09	56	0.12	0.10	98
7	142	0.60	0.11	61	0.17	0.05	102
8	143	0.83	0.23	68	0.22	0.05	103
9	140	0.96	0.13	63	0.33	0.11	102
10	152	1.20	0.24	69	0.46	0.13	103
11	155	1.40	0.20	72	0.64	0.18	104
12	173	1.53	0.13	74	0.75	0.11	105
13	176	1.62	0.09	73	0.84	0.09	105
14	185	1.80	0.18	80	0.94	0.10	105
15	192	1.97	0.17	82	1.05	0.11	106

[5] Steam Table and Diagram, by Marks and Davis.

TABLE I (*Continued*)

No. of hours	Top: Temp. of gases center °F	Top: Moisture loss dry basis (%)	Top: Loss per hour (%)	Bottom: Temp. of gases center bottom	Bottom: Moisture loss dry basis (%)	Bottom: Loss per hour (%)	Temp. of gases at main flue
16	177	2.13	0.16	79	1.20	0.15	108
17	186	2.26	0.13		1.38	0.13	110
18	201	2.40	0.14	84	1.52	0.14	110
19	190	2.53	0.13	85	1.62	0.10	110
20	183	2.59	0.06	95	1.64	0.02	115
21	206	2.62	0.03	98	1.82	0.18	118
22	212	2.98	0.36	100	1.93	0.11	120
23	220	3.09	0.11	103	2.06	0.13	125
24	212	3.16	0.07	106	2.18	0.12	126
25	251	3.27	0.11	112	2.31	0.13	130
26	265	3.53	0.26	120	2.48	0.17	132
27	280	3.79	0.26	125	2.66	0.18	136
28	332	3.88	0.09	130	2.79	0.13	140
29	330	4.08	0.20		3.16	0.37	147
30	345	4.08			3.23	0.07	151
31	387	4.12	0.04		3.60	0.37	158
32	392	4.14	0.02		3.84	0.24	166
33	394	4.14		180	4.12	0.28	172
34	408	4.17	0.03	190	4.24	0.12	180
35	406	4.18	0.01	203	4.34	0.10	188
36	452	4.18		217	4.40	0.16	195
37	490	4.20	0.02	230	4.45	0.05	204
38	516	4.21	0.01	244	4.46	0.01	209
39	541	4.26	0.05	258	4.52	0.06	
40	593	4.26		267	4.53	0.01	
41	627	4.26		281	4.55	0.02	
42	667	4.34	0.08	296	4.65	0.10	217
43	644	4.46	0.12	317	4.65		221
44	768	4.51	0.05	340	4.65		235
45	826	4.62	0.11	368	4.65		245
46	783	4.65	0.03	402	4.65		260
47	892	4.88	0.23	455	4.73	0.08	275
48	1230	4.95	0.07	480	4.77	0.04	292
49	1282	5.42	0.47	530	4.96	0.19	320
50	1390	5.55	0.13	605	4.97	0.01	335
51		5.73	0.18	635	5.15	0.18	350
52		5.85	0.12	680	5.15		370
53		6.22	0.37	710	5.32	0.17	385
54		7.00	0.78	740	5.35	0.03	435
55		7.50	0.50	784	5.71	0.36	460
56		8.43	0.93	813	5.83	0.12	487

TABLE II
GENERAL DATA GIVEN AS TYPICAL

Test no.	Plant no.	Kiln no.	Figure no.	Material used in ware	Weight of ware as set in tons	Weight of ware fired in tons	Pounds of water in ware	Per cent water in ware	Ignition loss of mixture in per cent
7	49	10	2	Eastern	83.1	73.9	5,416	3.4	8.1
8	49	31	2	Ohio fire clay	84.5	75.6	4,343	2.6	8.2
12	28	1	3	N. Carolina	87.3	77.3	7,536	4.5	7.5
14	28	1	3	shale	87.7	77.6	7,604	4.5	7.5
15	3	14	4	Ind. fire clay	62.4	56.6	2,336	1.9	7.6
18	3	14	4	Kentucky shale	61.3	55.9	4,570	3.8	6.1
24	42	18	5	Iowa fire clay	78.9	72.5	4,660	3.0	5.4
27	42	17	5	Iowa fire clay	83.7	78.4	4,140	2.6	4.1
32	11	3	6	Missouri	94.4	87.2	2,876	1.5	6.2
34	11	2	6	fire clay and shale	90.1	84.0	1,483	0.8	6.1

TABLE III

HEAT IN THE WATER VAPOR IN FLUE GAS FROM MOISTURE IN THE WARE DATA FROM TEST 8

Temp. of gases at main flue (1)	Total heat in vapor at temp. of moisture at main flue (see steam tables) (2)	Heat in liquid at starting temp. of ware 90°F (see steam tables) (3)	Difference item Nos. 2 and 3 (4)	Pounds of water per 1% moisture in suspended pieces (5)	Per cent moisture loss during previous hour. Av. of top and bottom (6)	B.t.u. used (item 4 by 5 by 6) (7)
97	1102.3	58	1044.3	1032	0.07	75,440
97	1102.3	58	1044.3	1032	0.03	32,332
98	1102.8	58	1044.8	1032	0.12	129,389
102	1104.5	58	1046.5	1032	0.10	107,999
103	1104.9	58	1046.9	1032	0.08	86,432

Continue calculation for each hour as indicated under calculations. The total will be 5,650,000 B.t.u.

(8) Curves There are two types of curves given. One type represented as Figs. 2, 4, and 5 shows a rapid moisture-loss rate at the beginning and a decided decrease in this rate at some point, which clearly indicates that all mechanical moisture has been removed. Of this type, Figs. 2 and 4 indicate this decreased rate, or the apparent end of free moisture loss, starting about 300°F and continuing at a slow

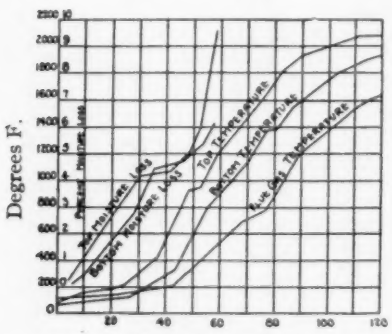

FIG. 2.

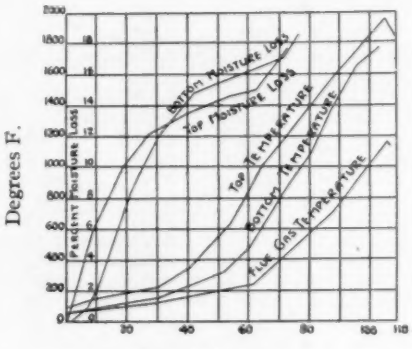

FIG. 3.

rate to about 900°F. Figure 5 shows the same decreased rate starting about 300°F and a more pronounced break at about 500°F.

Another point to note in Figs. 2, 4, and 5 is in regard to the break in the moisture-loss rate in the bottom of the kiln at around 230°F. This temperature seems more within the accepted range of mechanical water-free clay.

A fairly consistent point to note is the rapid weight-loss which starts between 800 to 900°F. In Fig. 6, for some undetermined reason, the

break in the top moisture loss is not revealed. This sudden increase in the rate of removal has been assumed to be the removal of chemical water.

Figures 3 and 6 show the other type consisting of a continuous but gradually decreasing rate of moisture loss through the low range of heating

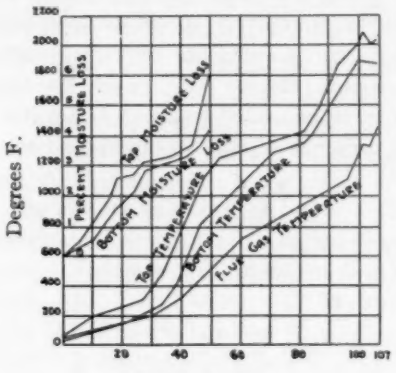

FIG. 4.

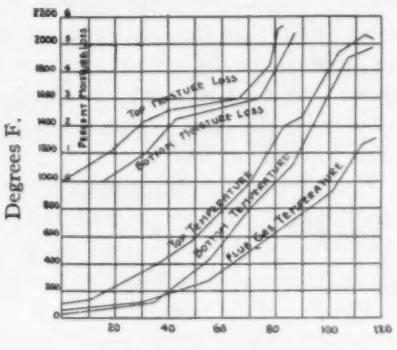

FIG. 5.

(200 to 400°F) with insufficient break to suggest the end of the free moisture-loss period.

IV. Discussion of Data

(9) Curves Although the reasons for the differences in the types of moisture-loss curves obtained were not fully answered, it seems plausible that they are dependent on the varying characteristics of the clay mixtures of the different bodies encountered. This was particularly true with respect to the fineness of, or the structure of, the aggregate and the affinity of the clay mixtures to hold on to the free water.

The two curves, Figs. 3 and 6, which show a continuous moisture-loss rate, were on clay mixtures high in shale and although the locations of the two tests were several hundred miles apart the type of curve is the same. Figures 2, 4, and 5 were fireclay bodies and clearly indicate the end of the free moisture period.

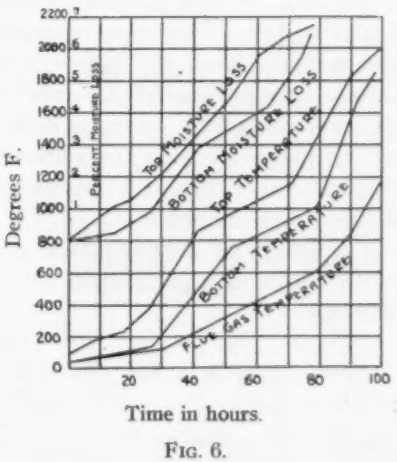

FIG. 6.

Relative to the slower weight-loss from 300 to 900°F, there is some ques-

tion as to the fundamental cause. Breaking down of the various salts could be the answer but it is not likely that the quantities of material as represented by the weight-loss would be equal. From this analysis moisture seems to be the reason. Should this be the case, moisture removal continues for the greater part of the firing schedule. The mechanical water removal, being continuous, would therefore cause speculation on the assumption that the heat required to drive this water from the clay would be identical to the values given in the steam tables. Affinity of clay for water may require greater heat quantities to be added to break the water loose from the clay. Water not in the presence of clay would show complete removal at 212°F.

Considering the continuous curves, Figs. 3 and 6, which as stated were shale bodies, it may be that the shales being of a finer-grained material could retain the water and not permit a sharp break in the moisture-loss curves when approaching the temperatures of 230 to 250°F.

Further, if the rate of ignition loss is sufficiently fast and immediately follows the removal of free moisture, the loss curve would be continuous. The data taken in the field were insufficient to determine these points.

(10) Tests in General It was observed that kilns set contained from 1483 pounds or 0.83 to 23,186 pounds or 12.0% free moisture. The average of all tests was 6784 or 4.4%.

The amount of heat required to drive the average weight of moisture from the ware, expressed in million B.t.u.'s, was 7.96 or 0.12% of the heat input.

This item is small when compared with the B.t.u. input, but is of great importance when the percentage of first quality ware is considered. Considerable savings are possible with better drying and watersmoking control.

The variations encountered emphasize the need for care in driving the free moisture from the ware and it is far more desirable to do this completely, or approximately so, under better controlled conditions. This can be accomplished by adequate drying equipment. Until this is recognized by the plant operators the watersmoking period will continue to require extreme care in manipulation and control if the time and losses are to be reduced to a minimum.

The length of time required to remove free moisture varied from 19 to 67 hours depending upon the amount present and the temperature schedule.

V. Conclusions

The study of moisture loss in kilns brought out two essentials for correct watersmoking period manipulation, which are: (1) strong draft during the early stages, and (2) accurate control of the top temperatures. The strong draft can be obtained by means of a large stack, but more standardized results can be obtained by use of a well-designed fan of correct

capacity. The top temperature schedule is dependent upon the amount of free moisture present in the ware, the thickness of the ware, and the characteristics of the clay with respect to affinity of the clay to hold its moisture. The usual pyrometer installation, with thermocouple incorrectly placed in the crown and lack of cold-junction compensation, is inadequate for indicating the watersmoking temperatures where time and careful control are necessary. The temperature was best measured by a bare thermocouple inserted through the kiln crown hole and removed around 600 to 700°F.

Measurement of loss of weight apparently does not indicate the critical point in the process when it would be dangerous to advance in temperature until further water was removed.

The results obtained suggest extensive laboratory investigations with respect to determining the affinity of the clay to hold its moisture and also in regard to the loss of weight at higher than normal watersmoking temperatures.

Acknowledgments The writer wishes to acknowledge the courtesy of Mellon Institute of Industrial Research and the Clay Products Association in authorizing this paper and to express his appreciation for the interest and help of E. Ward Tillotson, R. E. Arnold, and George H. Duncombe, Jr.

CLAY SEWERPIPE MANUFACTURE[1]

XI. A Simple and Inexpensive Cold-Junction Compensator for Outdoor Pyrometer Installations

By R. E. Arnold[2]

ABSTRACT

This paper describes an inexpensive, simple, and satisfactory method for multiple kiln installations to correct for cold-junction temperature variations.

I. Introduction

This paper deals specifically with some notes on plant pyrometer equipment, together with a method of correcting automatically for the cold-junction temperature variations which were made and tested during the extensive kiln investigation[3] conducted by Mellon Institute of Industrial Research, Pittsburgh, Pa., during 1926, 1927, and 1928.

The subjects pertain mainly to sewerpipe kiln operation but in many cases they can be applied satisfactorily to other industries where many temperatures are measured at scattered points some distance from the operating instrument.

Although kiln losses are not chargeable in their entirety to the firing operation, it is an accepted fact that correct firing schedules are essential for high quality.

A correct schedule, whatever it may be in any particular plant, for time and fuel economy must be operated close to the danger point and yet be safe, thus again calling for accurate temperature measurements.

The writer refers to accurate temperatures, meaning temperatures plus or minus 5°F from the actual.

From observations of kiln losses such as slabbing and carbon or carbon core, indications have been seen which point to the importance of accurate temperature measurement. A statement was repeated to the writer to the effect that a 50°F accuracy was sufficient for kilns. Any discussion of this remark could only lead anyone who knows about fast firing and good ware to believe that such an accuracy would be absurd. Yet, many pyrometer installations today are operating with the possibilities of even greater errors than 50°F, as will be pointed out later.

Most operators who have had experience with the installation and use

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Heavy Clay Products Division).

[2] Senior Industrial Fellow, Clay Products Association Industrial Fellowship, Mellon Institute, Pittsburgh, Pa., now with The Robinson Clay Product Co., Akron, Ohio.

[3] Conducted by R. E. Arnold (in charge), R. L. Blessing, E. A. Hertzell, H. C. Harrison, G. R. Pole, and C. E. Parmelee under the supervision of E. Ward Tillotson, Assistant Director of Mellon Institute.

of a pyrometer system already know that a couple should be (1) placed in the top one-third part of the crown, (2) extend at least four inches in from the inside surface of the crown, and (3) completely protected from furnace gases, but with a thin porcelain shell to decrease temperature lag.

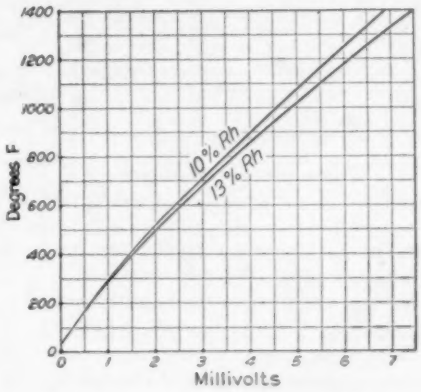

FIG. 1.—Rare metals, 32 to 1300°F.

II. Theory of Thermo-Electric Pyrometry

Principles of Pyrometry In 1821, Seebeek[4] discovered that if two metals (and incidentally different alloys of the same metal) are in a closed electric circuit, the two ends of the two materials at different temperatures, an electric current of small magnitude will flow in the circuit. This current is, therefore, dependent upon the different metals and the differential temperature between the two junctions. Any circuit so made, having one end at one temperature and the other at another temperature, is known as a thermocouple circuit or thermocouple. The welded end at the high temperature is known as the hot end or hot junction while the other end is the cold end or cold junction. For temperature measuring, the thermocouple proves of great value as it enables the determination of temperatures at any reasonable distance from the operator and, by use of the correct metals, temperatures as high as 2700°F can be ascertained.

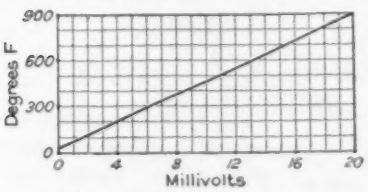

FIG. 2.—Chromel-alumel.

A thermocouple, therefore, consists of two unlike metals welded at one end, and the union placed where the temperature is to be measured, while the other end is kept at some constant or compensated temperature.

The electric current generated by the difference in temperatures between the known and unknown points is measurable. By calibration, the temperature-millivolt relation can be drawn, as shown in Figs. 1 and 2. For technical use the cold end is generally kept at a temperature of 32°F, while 70°F is generally used for practical conditions.

Figure 3 shows two circuits of the same metals. Circuit A consists of the couple wires alone, while circuit B shows the measuring instrument in-

[4] Taken from "Pyrometric Practice," Foote, Fairchild, and Harrison, Bur. Stand., *Tech. Paper*, No. 170.

corporated in the circuit. Under the same conditions the two millivoltages in both circuits are practically the same, the instrument reading in millivolts, from which the corresponding temperature can be found from the curves I and II, or else the instrument reads directly in °F for a given metal couple.

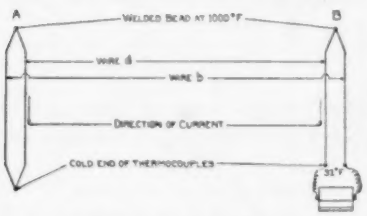

FIG. 3.—Showing current generation in two circuits. When temperatures of hot and cold ends are the same for both couples as shown in diagram, a current flows as is shown. Currents in each case are equal. Method of incorporating instrument in circuit to measure temperature with no effect on readings. Cold end of couple must be at 32°F or some arbitrary temperature.

Figure 4 shows the same temperature conditions but two thermocouples of different compositions. In such a case different millivoltages are developed requiring instruments of different calibration if direct temperature readings are to be shown on the instrument.

Figure 5 indicates by diagrams the effect of different cold-end temperatures on the same thermocouple when the hot end is at a given temperature. In this case the hot end is taken at 1000°F and the cold-end circuits A, B, and C, as 0°F, 32°F, and 132°F, respectively. Different millivoltages are developed in each case.

Should the instruments be calibrated to read directly in °F with a cold end of 32°F, then the errors in the instruments in the case of A and C will be 32°F plus and 100°F minus. It is this cold-end temperature variation which causes considerable trouble in the ordinary plant pyrometer installations.

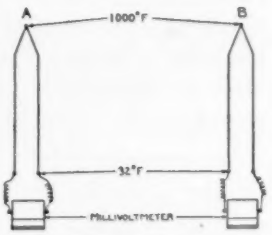

FIG. 4.—Thermocouple A—chromel-alumel wires = millivolts = 22.4; thermocouple B—platinum 100%-platinum rhodium (87–13%) = millivolts = 4.86.

Note: Showing differences in voltages developed in two thermocouples of different composition but having the same hot and cold end temperatures.

III. Discussion of Cold-End Compensation

It must be remembered that for every degree change in the cold-end temperature, assuming a constant hot-end temperature, there is a degree change in the reading of the instrument. That is to say, when the temperature of the cold end of the couple increases 100°F, the instrument reading decreases 100°F, and vice versa. This variation shows a change in reading in spite of no change in the actual hot-end temperature.

Without compensating wires, the cold end of a couple is many times close

enough to the kiln crown to be affected at high temperatures, and for low temperatures the atmospheric temperature alone will affect the instrument readings by the maximum variations from the cold-end calibration of the instrument as shown in Fig. 5.

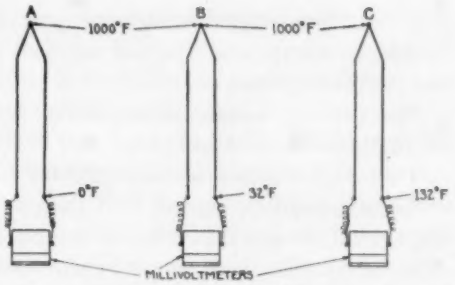

FIG. 5.—Showing effect of differences in cold-end temperatures. The greater the differential temperature the greater the millivoltage developed in the circuit. Should instruments be set to read 1000°F when cold end is 32°F, the temperature as indicated by all couples is shown below. Thermocouple A—chromel-alumel = 23.12 millivolts or 1032°F; thermocouple B—chromel-alumel = 22.4 millivolts or 1000°F; thermocouple C—chromel-alumel = 20.0 millivolts or 900°F.

Many pyrometer installations do not take into account the variations in cold-end temperatures. Probably the reason for this condition has been the resulting lack of understanding on the part of the management for the need of some kind of compensation of cold-end temperature variations and the unwillingness to spend $2000 to $5000 more for the complete outfit as recommended by the instrument companies. This extra cost is for what is known as compensating lead wires which extend the cold end of each couple to the instrument. For outdoor installations which require many thousand feet of such wire this cost is prohibitive to many plant operators and is seemingly unjustifiable.

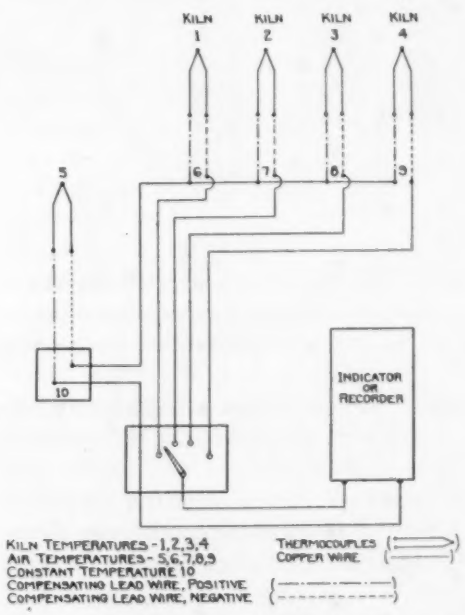

FIG. 6.—Wiring diagram of cold junction compensation by the use of an auxiliary couple.

IV. Auxiliary Couple for Cold-End Compensation

In Fig. 6 is shown the wiring diagram of a method which is recommended for multiple kiln installations, especially adaptable to yards where the kilns extend some distance from the instrument. The method is similar to a diagram shown in Bureau of Standards, *Bulletin*,

No. 170,[5] but changed to meet the ordinary kiln installation. This method is simple, cheap, and effective and can be installed on any system without any radical change.

The auxiliary couple, shown at No. 5, Fig. 6 will automatically take care of any number of kilns.

Two requirements are essential for the success of this method of cold-end compensation, namely: (1) extension of the cold end of each couple to a point where the cold-end temperature will be atmospheric and unaffected by kilns, and (2) placement of an auxiliary thermocouple in series

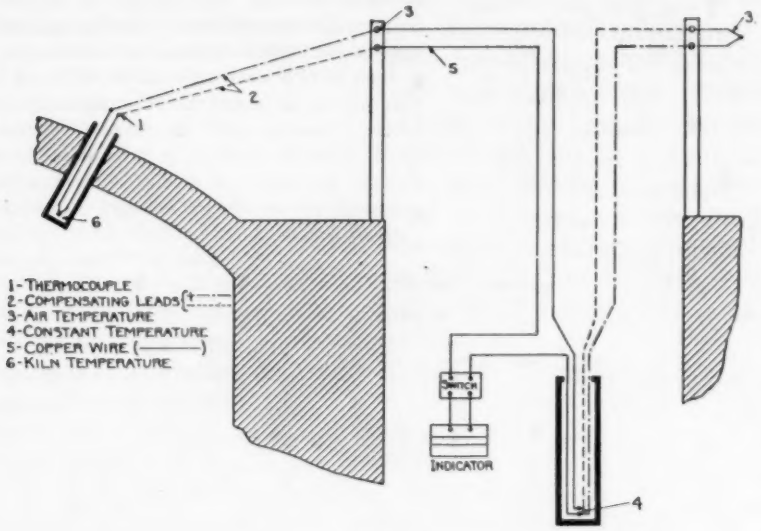

FIG. 7.

with the common return wire or one of the wires that lead from the switch to the instrument in such a way as to cause an addition or subtraction of millivoltage in accordance with the raising and lowering of the outdoor temperature.

To accomplish the first requirement: Figure 7 shows diagrammatically the placing of the compensating lead wire at the end of the thermocouple in the kiln to extend their cold ends to a post at the edge of the kiln. Compensating lead wire is thermocouple wire or its electrical equivalent which can be used as an extension instead of using the couple wire direct.

To make sure that the compensating wire is attached correctly it is advisable to make the connection to the copper leads at No. 3 (Fig. 7) first,

[5] Bur. Stand., *loc. cit.*, pp. 85–86.

and check the connection by touching the compensating leads at No. 1 together (Fig. 7) and heat to 300°F or 400°F.

If connections at No. 3 are correct, the instrument pointer will move up the scale as the temperature increases at No. 1 (Fig. 7). If the pointer moves down the scale past the zero, the connections should be reversed at No. 3. Having the connections correct at No. 3, there is only one way to connect the couple to the compensating lead wires and this is determined in like manner by applying a match to the welded end of the couple and noting the direction of the movement of the pointer on the instrument. If the pointer moves up the scale, connection is correct.

All points such as No. 3 (Fig. 7) should be in the same relative position on each kiln. Having completed the connections at the kiln, the attention can then be centered upon the auxiliary couple.

To install the auxiliary couple, a piece of compensating lead wire should be placed at the point similar to No. 3 (Fig. 7) and the two leads soldered together to form the hot end of the auxiliary couple.

This compensating lead wire should then be extended to some point of constant temperature (No. 4, Fig. 7) or to the instrument case. If the indicating instrument is equipped with a compensator, the lead wires should be placed in the instrument case. If no such compensator is used on the instrument, the cold end should be placed at some constant temperature. The writer has successfully used an underground point some 10 to 15 ft. down. The wire in this case should be well insulated and coated with asphalt, placed in a metal tube and the tube filled with asphalt to keep water from reaching the cold end. A small hollow tube can be placed adjacent to the cold end to permit the use of a thermometer to read the cold-end temperature of the auxiliary couple.

From the cold end, copper wires should lead to the instrument and be connected in series with the common return wire from all couples, or in the case of a two-wire system in series with one of the wires which lead from the switch to the instrument.

The correct way to make this series connection is shown in Fig. 8. In this case the common wire is shown as positive and under these conditions the negative wire of the auxiliary couple is to be attached to the positive wire from the kiln thermocouple or as is pictured in this case, the common return wire. The positive wire of the auxiliary couple should then be connected to the wire that leads to the positive pole of the instrument.

When the temperature of the cold junction (constant temperature point) of the auxiliary couple is below the temperature of the atmosphere, as is shown in Fig. 8, the current generated in the auxiliary couple will add to the current generated in the kiln couple, thus raising the instrument reading above the reading when no compensation is present. Conversely, when the air temperature falls below that of the auxiliary couple cold end

(constant temperature point), the current in the auxiliary couple will reverse and thus subtract from the current generated in the kiln couple, causing a lowering of the instrument reading. If, under the conditions of temperature of the hot and cold ends of the auxiliary couple cited above, the instrument temperatures are the reverse of what is outlined, then the auxiliary couple connections are incorrect and should be reversed. In other words, a correct connection will add or subtract readings, respectively, depending upon whether the atmospheric temperature is above or below that of the constant temperature point.

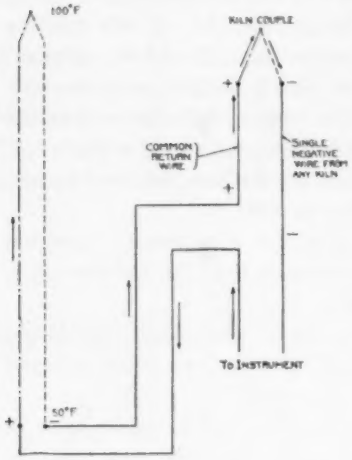

FIG. 8.

The pointer of the instrument in the case of a galvanometer type should be set at the temperature of the constant temperature point or auxiliary couple cold junction.

The cost of such a system is very small as compared to using compensating wire throughout the system. The only compensating wire used is for the auxiliary couple and kiln couple extensions.

STANDARD UNIT OF DIMENSION FOR MASONRY[1]

Discussion of Paper by Fred T. Heath[2]

By John Burchard, 2nd and A. F. Bemis

Introduction

It would scarcely appear necessary, and surely not tactful, to tell a group of ceramic manufacturers at a masonry symposium that they are among the backward members of modern industry; nor, indeed, would such a statement be strictly true. Within the industry you are progressive. Your research in the supply and properties of your raw materials, in the treatments of them from bin to shipping room, need accept criticism from no one. The purpose of this paper is, therefore, not to level criticism at your methods of production, and only partially to indict you for the wasteful and uneconomic use of your finished goods. The construction industry as a whole is not well. You alone cannot cure the patient. On the other hand, without your presence at his bedside his chances of getting well are materially hampered, if indeed not permanently deferred.

Reliable estimates indicate that the total construction in the United States exclusive of public works and utilities for the year 1930 will cost upward of seven billion dollars.[3] Of this it is estimated that five billion dollars will be in the hands of architects. Since architects control the erection of the bulk of the larger buildings, apartments, and high-priced single dwellings, it is fair to assume that 50% of the unsupervised work will be in the construction of dwellings by speculative builders. In addition to this billion dollars' work, it is estimated that two hundred and seventy million dollars will be spent on detached houses costing under $50,000, built under architectural supervision, a mighty industry aggregating conservatively one and a quarter billion dollars of new construction annually, chiefly to be spent by people who cannot afford waste, yet an industry almost completely haphazard and wasteful, subject to the whims of many a chance.

It is hardly necessary to point out the difficulties that the motor car industry would face under similar circumstances. Mr. Ford may, if he likes, select every piece of his own automobile, design a novel pocket flap, a special windshield wiper, a carburetor of idiosyncrasy, have the pieces brought to his garage, and employ expensive mechanics to assemble the car entirely at his own whim. We can guess what it would cost him. If

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[1] Presented at the Annual Meeting, American Ceramic Society, Toronto, Ont., February, 1930 (Masonry Symposium).

[2] *Jour. Amer. Ceram. Soc.*, **12** [10], 605–39 (1929).

[3] 1930 National Building Forecast, *Architectural Forum, et al.*

automobiles were built on the principles pertaining in the small building industry, the problems of traffic congestion would never have arisen.

About the same contrast with the building industry may be found in the production and sale of every other necessity and many of the luxuries of the man of 1930. Package foods have come to be a byword and they are found in any desired quality. They grace the pantry shelves of rich and poor alike. A well-to-do-man may, if he likes, pay a premium for clothing and have it made to his order, but there is scarcely a modern Croesus who has the pattern of his goods determined that way and the modest purchaser need not feel himself at any disadvantage sartorially if he uses discrimination in the selection of his clothing from the voluminous stocks of those produced en masse. It is quite safe to say that the provision of mass shelter is the only major industry of this day that still performs its operations from hand to mouth.

I have carefully discriminated between the provision of shelter and the other phases of the building industry because it is quite apparent that the construction of a Chrysler building is an operation of sufficient magnitude to justify careful preliminary planning and the skillful uninterrupted and economic flow of material from mill to the top-most peak of the aluminum-clad tower. In some measure shelter is also provided with this same forethought which begins to approach the mass production of buildings. This is so in the case of apartment hotels and large apartment buildings. No one, however, can seriously defend the position that apartment dwelling is ideal for American domestic life.

The purpose of this paper is therefore to point a road by which the savings of mass production may be extended to the man who still has a sentimental desire to live in a house of his own but whom present economic forces have cooped up in cramped quarters without personality and at a cost far in excess of what the economists say should be allotted to shelter in a scientifically planned budget. This road also leads to savings even in Chrysler buildings, but because of economies obtainable by standardization with the latter structures naturally those here proposed are not so significant proportionately as those obtainable in the isolated dwelling.

House Building on Mass Production Basis

It is quite true that there are occasions when the building of single dwellings approaches mass production, even under the present rough and ready methods. For example, there are the building projects of the London County Council, involving many developments including that very large one at Becontree of 26,000 houses for 130,000 people, on an estate of 3000 acres just ten miles from Charing Cross. Here in lots of 1000 or more the Council completes a brick house every five minutes of the working day. Artisans move from house to house, performing the same operation on each

job. Since the materials used are in themselves produced economically, routing of this magnitude evidently in itself involves the advantage of mass productive principles and makes possible a considerable degree of savings in production of houses. It is at once apparent that such operations are exceptional and no general solution to the problem.

At this point let us be very clear about what we mean by mass production of houses. It is, of course, evident that the individual materials coming to the site are capable of standardization and its concomitant mass production. Your own brick and tile are good examples of this. But once laid on the site the production has only begun. To compare building with the manufacture of automobiles suppose that we should lay before a skilled mechanic, bolts, nuts, cylinder heads, fans, belting, pistons, spark plugs, sheet steel, shafting, gears, electric wires, and paint, each produced according to a standard, and asked him to build for us a Ford car. This is not even quite a fair picture. To be comparable to the present system of building dwellings, the mechanic would have to find the bolts of different diameters than the nuts, the pistons built to a different standard than the cylinders, and that the gears did not mesh, and then cut, saw, file, turn, trim, and fit, every single item requiring at least one of these operations.

Common Denominator of Dimensions Needed

An ordinary brick dwelling utilizes the products of at least thirty industries. The majority of these products may be and probably are standardized within their respective industries but the standards are the result of accident, tradition, or of old and obsolete convenience and bear no relation one to the other. Let us put on a single sheet of paper standard dimensions of brick, steel joists, window frames, glass, insulating sheets, bath tubs, finish tile, kitchen cabinets, and shingles. I do not need to suggest to you what a chaos of figures and fractions there will be. It is little wonder that the artisans who fit these various standards together into something approaching a homogeneous unit are called skilled workers. What the building industry badly needs is a common denominator of standardization.

Fred T. Heath, in his very able paper, has already pointed out the vital need of this denominator for your industry and its partner, the window and door business. We agree with him in his abstract conclusions but we would extend them much further to include the other manifold activities of building. This extension is simpler than would at first appear. It is done by what we call cubical modular planning.

Cubical Modular Planning

It will be convenient in explaining cubical modular planning to refer to the modulus we have adopted, *i.e.*, 4 inches, and to illustrate our suc-

cess with one of the later types of wall with which we have chiefly experimented, *i.e.*, those made up of steel frame and filler elements. The example thus given must not be interpreted as indicating that we necessarily think that 4 inches is the ultimate common denominator for the

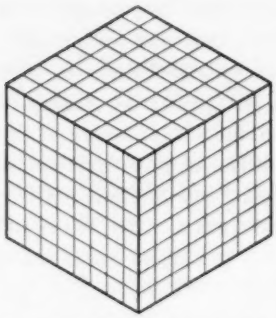

FIG. 1.—The side of each smaller cube is our module.

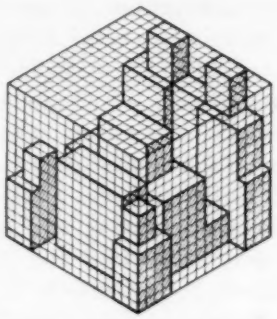

FIG. 2.—"We may take away cubes—".

building industry or that modular planning is not readily applicable to masonry. In fact, we are ready to adopt any modulus that seems to work out best for the industry as a whole and, as I shall try to show, it is quite simple to work out a basis that will tie in nicely with the salutary advances you have already made in coöperation with the steel window manufacturers.

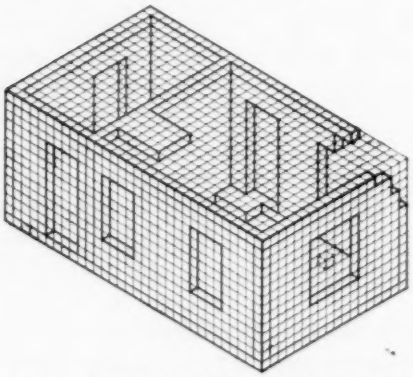

FIG. 3.—Excavate cubes to form our rooms, our door, and window openings.

The first thing we must be very clear about is that cubical modular planning is three-dimensional. Despite its name, despite the stress we may lay on its nature, I constantly find people going back to the idea that all we are proposing is to have architects draw the horizontal plans of buildings on cross-ruled paper, yet this is probably the least important thing that cubical modular planning makes possible.

Perhaps the easiest way to visualize cubical modular planning as a three-dimensional affair is to consider our projected building first in the form of a large cube made up of a great number of equivalent smaller cubes (Fig. 1). The side of each smaller cube is our module. Then just as the child takes away blocks, we may take away cubes until we have

secured the external mass of our building as we want it (Fig. 2). Evidently this mass will be modular in every direction.

The next step in imagining the modular system requires us for the moment to forget gravity and to conceive of any single cube as being capable of suspension in air. Needless to say, this has nothing to do with our final structure and is only of convenience in picturing the procedure. Owning these self-supporting cubes, we may then break into our external mass and excavate cubes to form our rooms and our door and window openings (Fig. 3). The result is a structure made up of positive and negative cubes, positive cubes forming walls and floors, negative cubes forming room spaces. All walls will be an integral multiple of the basic module in thickness, length, and height. So, too, will be floors. Distances between floors or walls will be integral multiples of the module. Window and door openings are modular multiples in width, height, and thickness, as well as centering.

If we could stop here and have self-supporting members, free from necessity for connection to each other, free from mortar or hinges, the modular system would be easily understandable by any one. One sees at once that in this event all the structural and finish members that go to make up a building would be exactly integral multiples of the modulus. Standardization of every element of the building could thus be obtained with comparatively few sizes.

Of course this does not meet the facts. Steel or wood beams must rest on masonry walls, must be attached to other steel or wood members. Mortar is required. The solution is none the less easy. We will adopt a standard bearing dimension, a standard connection, and a standard centering of masonry joints. Then none of our joists may come out to be an integral multiple of the modulus but it is still true that our various sizes differ one from the other by an exact modular multiple and this is the thing that permits mass production and the stocking of comparatively few parts which will fit with all other parts. Figure 4 shows how this works for steel beams bearing with a constant dimension "c" on modular masonry walls. The length of the beams is always a constant multiple of the module plus $2c$. Similarly, the actual dimensions of windows fitting into a wall opening which in itself is modular may, indeed probably will, be fractional but these windows will vary one from the other by an exact multiple of the module. So, too, will the glass. (Fig. 5.)

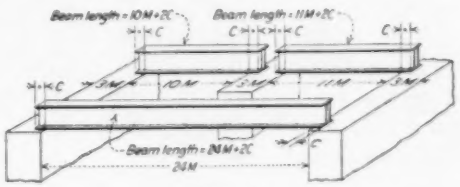

FIG. 4.

On the finish side, wood paneling made modularly with proper clearances

will fit modularly planned walls. So will bathroom tile, gypsum lath, insulating boards, mantels, and matched floorings. Kitchen fixtures and even the majority of plumbing elements, sinks, bath tubs, washbowls, can easily fall into line. The possibilities for pattern design are at once apparent.

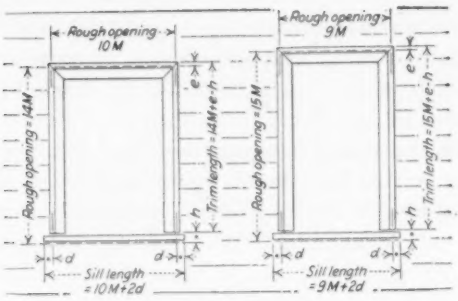

FIG. 5.

I have been unusually successful in my exposition if at this point you are not condemning me for advocating rows of block houses. This is exactly what we do not want. With cubical modular planning, Mr. A may have everything different from Mr. B, his neighbor. All of Mr. A's house parts differ from Mr. B's only by multiples of a module. Mr. A may have an architect, Mr. B may build his own house, but each can buy his modular parts from the thirty industries which serve him and find that when they come to the site they fit.

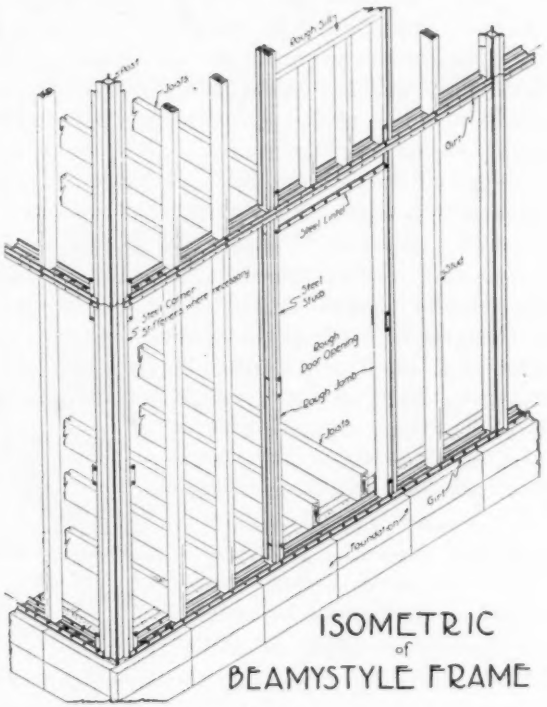

FIG. 6.

The requirements for a suitable cubical module are that it be small enough to allow full flexibility of design and treatment, large enough not to force an infinite multiplication of sizes, and that it be a common denominator best suited to the majority needs of the building products industry. One such module we have arrived at by taking as the denominator the nominal structural wall thickness of a 2 by 4 stud wood

frame house. This thickness is 4 inches. How it works will appear clearly from a brief consideration of one of our steel building frames in particular, the one we have adopted for use with wood studs and floor joists. (Fig. 6.)

You will note that this frame is made up of posts and girts, the wall width of each being the module 4 inches. Both are punched at 4-inch intervals along their lengths with two sizes of holes for different purposes. Thus the length of the members need not be determined at the moment of manufacture. Our stocks will contain all the lengths experience shows are likely to be needed in ordinary construction, some three or four for the posts, some dozen stock lengths for the girts. Other sizes or lengths similarly modular may be quickly or readily made from the stock of component modularized parts. You will observe that the girts are not an integral multiple of the module in length but their lengths do differ by this module. When they are put in the building they are an integral modular multiple center to center either in section, elevation, or plan. The small holes accurately place joists and studs at exact modular centering. These studs and joists are themselves different one from the other by exact multiples of the module. Their modular centering in turn permits the attachment of any kind of finish which also is modular. The thing goes together like clockwork.

But you are not particularly interested in steel frames. I think it is evident by now that a simple extension of Mr. Heath's ideas gives you our proposal. The only concession we would have to make in mortared masonry is that the masonry wall is to be the thickness of an integral modular multiple minus the thickness of one joint. A little consideration will show that this does not bother either you or us.

Conclusion

We have followed with great interest your studies in Washington. It is our understanding that the present proposed basis of standardization is $4^1/_2$ inches in the horizontal plane and 3 inches in the vertical plane. If this proves best for the industry, we can work with it, but it will impose some restrictions on us since to carry the modular plan into the other phases of the building industry we will have to adopt a module either $1^1/_2$ inches on a side, permitting us to use all your standards, or 9 inches on a side permitting use of only a portion. The one is probably too small, the other too large for complete economy.

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Abrasives

Abrasive materials in 1928. OLIVER BOWLES. Bur. Mines, *Mineral Resources U. S.*, Part II, pp. 237–52 (1928).—The report gives detailed production statistics on such natural abrasives as millstones, grindstones, pulpstones, oilstones, and other whetstones, corundum and emery, garnet, tripoli, diatomite, pumice and pumicite, imports and exports, and artificial abrasives. R.A.H.

Abrasive engineering progress. ANON. *Abrasive Ind.*, **11** [6], 39 (1930).—Manufacturers engaged in cold rolling of metals are being called upon for new standards of quality both in uniformity of gage and character of finish. Norton Co., manufacturers of grinding machines and grinding wheels, has worked very closely with many of the

rolling mills in its efforts to satisfy customers. Wheels are now available that cut freely, remove stock rapidly, and at the same time leave a finish heretofore unobtainable except by slow and careful work. One of the new machines recently placed on the market by Norton Co. is the 28 in. type D machine, built in lengths from 96 in. up. A table for selection of wheels for roll grinding follows:

WHEELS FOR ROLL GRINDING

New Rolls of Hardened Steel

Operation	Wheel
(1) Rough grind	46-D grit, K grade, Alundum vitrified
(2) Semifinish grind	100 grit, I grade, Crystolon vitrified
(3) Finish grind	400-A grit, I grade, Crystolon shellac

New Chilled Iron Rolls Rough Turned

(1) Rough grind	36-B grit, T2 or T3 Alundum Bakelite
(2) Finish grind	36-B grit, " " " " "

Regrinding Hardened Steel Rolls

(1) Rough grind	100 grit, I grade, Crystolon vitrified
(2) Finish grind	400-A grit, I grade, Crystolon shellac

Regrinding Chilled Iron Rolls

(1) Rough grind	36-B T2 or T3 Alundum Bakelite
(2) Finish grind	36-B T2 or T3 " "

E.P.R.

Is close grain size essential? HENRY R. POWER. *Abrasive Ind.*, **11** [6], 46–47 (1930).—Abrasive grains have a heterogeneous lot of shapes. This irregularity of shape presents many difficulties in defining accurately by linear measurement the permissible range of sizes of the particles. Sieving is an analytical method of measuring the fineness of a mixture. Doubt exists about the value in the abrasive industry of extremely closely-graded grit sizes. Experience does not favor the extremely closely-graded product. Vigilance to prevent coarse grit contamination should not be slackened nor should "contamination" be mistaken for "inaccurate sizing." Other properties of abrasives such as surface tenacity, capillarity, and toughness play a more important part in the efficiency of the polishing wheel than very close or theoretical accurate grading. E.P.R.

Field for high-speed wheels. REVERE CHAPELL. *Abrasive Ind.*, **11** [6], 31 (1930).—High-speed wheels are for rapid removal of large quantities of material. Until heat is generated to soften the material being removed there cannot be even an approach to efficiency. Heat is essential. There is nothing in the abrasive wheel to prohibit generation of heat in the chips to any degree up to the complete oxidation of the chip. Heat, in the chips, is absolutely indispensable and the hotter the work surface is made by the abrasive action, the easier it is for the abrasive teeth in the wheel face. Most wheel breakages are due to unevenly distributed heat. The faster wheel does not heat itself as rapidly as does the slower wheel, because the faster wheel ventilates itself more efficiently and requires less pressure to be applied than does the slower one that must cut colder tougher material. High speed should be used when possible because it permits the wheel to condition the surface of the work. E.P.R.

Polishing compound. ANON. *Abrasive Ind.*, **11** [6], 48 (1930).—For polishing and grease-wheel operations on stainless steels and rustless irons, the E. Reed Burns Mfg. Corp., Chicago, Cleveland, and Brooklyn, have a new product called aluminite paste.

As the abrasive should be free from any great amount of ferric oxides, this paste contains no iron. It is a hard paste of different grades of abrasives and lubricant. E.P.R.

To standardize abrasive grain. ANON. *Abrasive Ind.*, **11** [6], 25 (1930).—Producers and users of aluminium oxide and silicon carbide abrasives met at the Simplified Practice Division, Bureau of Standards, Washington, May 8, and adopted recommendations which were suggested by the technical committee of the producers of electric furnace abrasives establishing 19 sizes of abrasive grains. Prior to the general conference held on May 8 the producers met and made some changes in the recommendations which had been presented previously to the trade. These latter recommendations which were finally adopted by the conference are as follows:

ALLOWABLE GRAIN SIZE LIMITS

Grit No.	Minimum of 100% through screen	Control No.	Control Screen Opening in in.	Maximum oversize on control	Minimum of percentage	Cumulative minimum	Maximum of 3% through screen
10	7	8	0.0937	15	45 on 10	80 on 10 and 12	14
12	8	10	0.0787	"	" " 12	80 " 12 " 14	16
14	10	12	0.0661	"	" " 14	80 " 14 " 16	18
16	12	14	0.0555	"	" " 16	80 " 16 " 18	20
20	14	16	0.0469	"	" " 18	80 " 18 " 20	25
24	16	20	0.0331	20	" " 25	75 " 25 " 30	35
30	18	25	0.0280	"	" " 30	75 " 30 " 35	40
36	20	30	0.0232	"	" " 35	75 " 35 " 40	45
46	30	40	0.0165	"	" " 45	75 " 45 " 50	60
54	35	45	0.0138	"	" " 50	75 " 50 " 60	70
60	40	50	0.0117	30	" " 60	65 " 60 " 70	80
70	50	60	0.0098	15	" " 70	70 " 70 " 80	100
80	60	70	0.0083	"	40 " 80	70 " 80 " 100	120
90	70	80	0.0070	"	" " 100	70 " 100 " 120	140
100	80	100	0.0059	"	" " 120	65 " 120 " 140	200
120	100	120	0.0049	"	30 " 140	60 " 140 " 170	230
150	100	140	0.0041	"	40 " 170 and 200	75 " 170, 200 and 230	270
180	120	170	0.0035	"	" " 200 " 230	65 " 200, 230 " 270	
220	140	200	0.0029	"	" " 230 " 270	60 " 230, 270 " 325	

Note: These specifications apply to the sizing of aluminium oxide and silicon carbide abrasives for polishing and for grinding wheel manufacture. They shall not apply to abrasives used in the manufacture of abrasive paper and cloth products (coated abrasives).

The screens referred to above are those of the U. S. standard series certified by the U. S. Bureau of Standards, or equivalent. 100 g. are shaken 5 min. on a suitable testing machine. E.P.R.

New type filter for grinding compounds. ANON. *Abrasive Ind.*, **11** [6], 41 (1930).—An ingenious self-contained type of filter embodying a self-contained externally-operated, cleaning arrangement recently has been introduced by the Cuno Engineering Corp. The filtering element consists of a stack of thin metal washers spaced and held internally by a central shaft. The compound to be filtered enters the filtering cartridge from the outside, passes through the fine spaces or slots between the disks of the filtering element, and flows up through the interior space and out the outlet pipe. The filter cartridge may be rotated periodically by an external ratchet, or if continuous automatic cleaning is desired, the cartridge may be geared to a small motor. The filtering cartridge is indestructible and will not collapse even under high pressure. E.P.R.

Surface grinding machine design reveals production grinding development. FRED B. JACOBS. *Abrasive Ind.*, **11** [6], 22–25 (1930).—Progress made in the design of surface grinding machines during the past half century represents one of the most interest-

ing points of mechanical development. There are 12 common types of surface grinding machines, each a distinct departure from previous models. Surface grinding with abrasive wheels is supposed to have developed nearly a century ago, the workmen making their own emery wheels of a mixture of glue and emery. Early machines were improvised from iron planers. Improvements made are the magnetic chucks for locating and holding the work, automatic features, and hydraulic drives. Various stages of the development of surface grinders are illustrated and described. E.P.R.

New grinder runs at high speed. ANON. *Abrasive Ind.*, **11** [6], 40–41 (1930).—The Standard Electrical Tool Co., Cincinnati, recently introduced its new standard 24 to 30 in. heavy high-speed floor stand production grinder. A working range of 7500 to 9000 surface feet per minute is promised under ordinary operating conditions. E.P.R.

Electric bench grinder. ANON. *Abrasive Ind.*, **11** [6], 42 (1930).—This machine is an electrically-driven bench grinder developed recently by Wappat, Inc. The grinder is furnished for any standard voltage in either alternating or direct current. It is fitted with substantial wheel guards and wide work rests. The wheels are 6 in. in diameter, $^1/_2$-in. face, and $^1/_2$-in. arbor hole. E.P.R.

Varied uses for bench-type pedestal grinder. ANON. *Pit and Quarry*, **20** [5], 78 (1930).—Ingersoll-Rand Co., New York, announces a bench-type pedestal grinder, known as the Type 9, which can be bolted to a bench or a portable air compressor. The flow of air to the motor is controlled by a hand-operated globe valve. The machine has a free speed of 3000 r.p.m. and is designed to take a vitrified grinding wheel of 6 in. or 8 in. diameter with a $^1/_2$-in. face. E.P.R.

New Van Dorn Flex-Disc grinder. ANON. *Pit and Quarry*, **19** [3], 116 (1929).—The Van Dorn Electric Tool Co. has just announced a new 7-in. Flex-Disc grinder in addition to its present 9-in. grinder. The improvements made on the 7-in. grinder have been included on the 9-in. grinder. E.P.R.

Preparation of surfaces for chromium plating. ANON. *Abrasive Ind.*, **11** [6], 44–46 (1930).—This article described briefly a few polishing operations performed at the plant of the Olds Motor Works, Lansing, Mich., in preparing surfaces on bumpers and radiator wheels for polishing before plating. E.P.R.

Roll-grinding precision. ANON. *Abrasive Ind.*, **11** [6], 29–31 (1930).—Grinding is the most satisfactory method of finishing and maintaining all types of rolls. The economy effected is alone sufficient to commend the practice. By the old method much valuable metal was removed from the surface at each retruing. The precision grinding machine removes only the minimum of metal. The surface produced by the grinding wheel is more durable than that produced by the tool, thus the length of time between retruings is greatly extended. E.P.R.

Cams are ground accurately. ANON. *Abrasive Ind.*, **11** [6], 26 (1930).—Large cast-iron cams of various sizes and shapes are incorporated in bottle-making machines built by the Kent Owens Machine Co. The raceways for the cam rollers were originally machined. Difficulty with these cams was experienced. They are now ground accurately by abrasive wheels and the trouble has been eliminated. E.P.R.

Grinding boiler sections. ANON. *Abrasive Ind.*, **11** [6], 18–21 (1930).—Modern heating boiler sections must fit with accuracy. Abrasive processes are used advantageously in fitting these sections, and this article illustrates and describes some of the grinding operations followed in finishing heater units at the plant of the Bryant Heater & Mfg. Co., Cleveland. E.P.R.

Grinding large crankshafts. ANON. *Abrasive Ind.*, **11** [6], 41–42 (1930).—The finishing of pin and main bearings of crankshafts on precision grinding machines has for a long time been accepted as the most economical means of obtaining the accuracy

and high finish necessary on these parts. Owing to the high degree of accuracy and perfect finish demanded, the machining of this class of work is particularly applicable to grinding machines. E.P.R.

New trends shown by Cleveland foundry exhibit. ANON. *Abrasive Ind.*, **11** [6], 27–28 (1930).—At the 34th Annual Convention of the American Foundrymen's Assn. held in the Public Auditorium, Cleveland, May, 1930, abrasive equipment of the latest types was shown. Great strides have been made in grinding-wheel development. Abrasive equipment in great variety, perfected especially for the foundry industry, was displayed by many manufacturers. E.P.R.

PAMPHLETS AND BULLETINS

Abrasive report published. ANON. *Abrasive Ind.*, **11** [6], 35 (1930).—A pamphlet, Abrasives, has been published by H. M. Stationery Office, London, England, as a part of the report of the Imperial Institute on the mineral resources of the British Empire and foreign countries. Following a general review of the nature and uses of the various abrasive substances available, each type of abrasive is classified and its sources and uses discussed. Production figures are given and listed according to countries and years. A bibliography on abrasives and a list of other reports of the Imperial Institute are included. The pamphlet may be secured in the U. S. by writing to the British Library of Information, 5 E. 45th St., New York. E.P.R.

Grinding equipment. ANON. *Abrasive Ind.*, **11** [6], 43 (1930).—The Hammond Machinery Builders, Inc., Kalamazoo, Mich., has just issued its new bulletin No. 20 which illustrates and describes grinding and polishing machines fitted with motor air cleaners. The bulletin includes descriptions of tool grinders, production grinders, casting snaggers, combination disk and production grinders, double-disk grinders, motor on spindle polishers, twist-drill grinding machines, ring-wheel grinders, multi-speed casting grinders, and combination grinders and buffers. E.P.R.

High-speed grinders. CYRIL A. FOX. *Abrasive Ind.*, **11** [6], 43 (1930).—F. has issued a pamphlet illustrating a line of high-speed production and swing-frame grinders Drawings showing constructional details of the wheel mounting used and of the frame construction of the swing grinders, are included. E.P.R.

PATENTS

Portable grinding tool. ERNEST A. HALL. U. S. 1,760,493, May 27, 1930. In a tool, a guide fixed with respect to the work, a shaft rotatable on the guide in eccentric relation thereto, a second shaft rotatable on the first shaft, a rotary abrasive member carried by the second shaft without the guide, and positively driven intergeared means for imparting rotation to the first shaft about the guide and to the second shaft about the first shaft.

Work holder for grinding machines. ALDEN M. DRAKE. U. S. 1,760,587, May 27, 1930. In a machine tool, a holder for cylindrical work comprising a hollow cylindrical sleeve having an internal flange, a hub member in which the sleeve is centered and supported, means engaging the sleeve for yieldingly seating the sleeve in the hub member and thereby clamping a plurality of work pieces between the internal flange of the sleeve and a shoulder fixed with respect to the hub member, and means to center the work pieces in the cylindrical sleeve, the means comprising springs mounted on the inner face of the cylindrical sleeve and yieldingly engaging the outer walls of the work pieces.

Grinding machine. NORMAN H. KLAGES. U. S. 1,760,987, June 3, 1930. The combination with a plate for supporting a sheet whose edge is to be ground, a support-

ing bed in front of the plate, a block carried by the bed, a sleeve threaded through the block for endwise adjustment and provided upon its interior with bearings, a work spindle journaled in the bearings and movable endwise with the sleeve, a grinding wheel carried by the spindle, means for rotating the sleeve to adjust it endwise through the block comprising a worm wheel splined to the sleeve and swiveled against axial movement relative to the bed, and a worm for rotating the wheel, a motor carried by the bed and connecting means between the drive shaft of the motor and the spindle with which the spindle has a splined engagement to permit of the endwise adjustment of the spindle.

Grinding machine. WILSON P. HUNT, CLARENCE W. HALLENE, AND SAMUEL L. BRANDENBURG. U. S. 1,761,126, June 3, 1930. In a device of the class described, a housing, a spindle rotatably mounted therein, and provided with a cylinder on one of its ends provided with external longitudinal channels, a cone member supported in the cylinder, and having a clearance from the sides of the cylinder permitting a limited lateral flexibility of the cone member, frames in the channels capable of radial expansion, contact members connected with the frames in engagement with the cones of the cone-member, means for holding the frames under inward tension and means for moving the cone member to actuate the frames.

Polishing disk. GUSTAV LÜDORF. U. S. 1,761,890, June 3, 1930. A polishing device comprising a plurality of layers of a fabric originally manufactured as a spiral band, each layer consisting of a section corresponding to a single spiral convolution converted into a plane disk.

Cylinder-grinding attachment for lathes. FREDERICK H. GJESDAHL. U. S. 1,762,658, June 3, 1930. In combination, a rotatably mounted lathe face plate, shaft supporting means secured at one side thereof, a shaft rotatably mounted in the supporting means, means for eccentrically adjusting the shaft with respect to the face plate, a shaft extending outwardly from the opposite side of the face plate operable independent of the operating means for the face plate, and means operatively connecting the shafts comprising a plurality of pulleys arranged in triangular formation on one face of the face plate, one of the pulleys being mounted on the last-named shaft, a pulley mounted on the inner end of the first-named shaft, and belt drive means trained over the pulleys for operatively connecting the shafts, and automatic belt tightening means carried by the face plate operable to maintain the belt under operative tension in accordance with the adjustment of the first-named shaft.

Magnetic throw-off for grinding machines. FREDERICK D. VAN NORMAN. U. S. 1,763,201, June 10, 1930. A machine comprising a feed ratchet, a pawl for rotating the ratchet, a striker movable through a substantial free travel to contact with the pawl to disengage it from the ratchet, a work-controlled electromagnet, an armature movable by the force of the electromagnet and normally spaced from it, and mechanism coupling the armature and striker and so proportioned that a movement of the armature causes a movement of the striker of greater amplitude.

Truing abrasive wheels. J. BATH. Brit. 327,003, May 14, 1930. In a grinding machine particularly for grinding a tap, the grinding wheel is trued by means of a pair of diamond tools which operate alternately at selected rates of speed on opposite sides of the wheel. The dressing mechanism is mounted on a table slidable on a plate adjustably secured to a bar clamped to the wheel carriage. The plate is fed toward the grinding wheel by means of a feed screw actuated by a ratchet wheel which is rotated by a pawl mounted on a feed lever rocked by an eccentric on a hand-operated shaft. Preferably the dressing tools are advanced $^1/_{1000}$th inch at each rotation of the shaft. The diamonds are carried by swiveling heads and are adjustable by screws.

Art and Archeology

Report of the Committee on Terminology of the Federated Council on Art Education. W. G. WHITFORD, L. TAFT, AND R. P. ENSIGN. *Amer. Mag. Art*, **20** [10], 600 (1929).—A Committee of the above has labored for years to clarify art terms which have befogged the issue. Dictionaries have been examined, authorities consulted and compared, and no pains has been spared to fix meanings and ascertain frequency of use. E.B.H.

Technique of art drawing and metal decoration. H. C. WILHELM HANNICH. *Glas-Ind.*, **37** [12], 183 (1929).—While the stained glass worker of the Middle Ages had only two or three colors to work with, the modern artisan has a complete range of colors. Some of the various types of coloring materials, their preparation, and uses are discussed in detail. The technique of applying these colors to glass and metals for the purpose of decoration is taken up. E.J.V.

Preparation of glazes and enamels. G. MILANI. *Corriere ceram.*, **11** [1], 23–27; [3], 93–99 (1930).—Ceramists who wish to cut down the cost of production by manufacturing at their own plant the glazes and enamels they require, instead of buying the more expensive prepared products, are given directions for constructing the kiln, and for preparing and fusing the frits or glazes. M.V.K.

Decorating glass without aid of lead cements or enamels. ANON. *Ceram. Ind*, **14** [6], 658 (1930); *Nat. Glass Budget*, **46** [5], 30 (1930).—A new process by which a desired pattern can be formed as a layer of pieces of colored glass and then fused with a thin sheet of plain white glass has been evolved and patented by Basil R. Bayne of England. The colored and plain glasses have the same melting point and expansion coefficient. Bayne calls the method "Lapis Regis." It will no doubt replace much leaded glass work, especially where small areas of sheet glass are concerned, as it gives the artist greater freedom of design and detail. W.W.M.

Stained glass in domestic use. J. A. KNOWLES. *Notes and Queries*, **158**, 189–90 (1930).—The earliest English record is, in 1241, an order to place two windows in the Hall at Westminster. The earliest in Germany dates from the 10th Century, and concerns the glass in the Bavarian monastery Tegernsee. H.H.S.

Glass staining and technical glazing in Rio Grande do Sul. ANON. *Glas-Ind.*, **37** [11], 170–71 (1929).—A brief discussion of the stained glass industry in Brazil is presented, naming some of the leading firms in the field. E.J.V.

Specialties in china and glassware. ANON. *Pottery Glass & Brass Salesman*, **41** [18], 23 (1930).—Morimura Bros. Inc., are showing a new dinnerware including the "Imperial" shape, the big feature of which is the edge. It is slightly indented at regular intervals being carried out on the cover of the hollow ware. Flat enamels are used in odd fashion. Many of the filled-in decorations look as though they had been done by hand. They are set against an ivory ground lay. The Duncan and Miller Glass Co. is displaying a fruit cocktail and liner not unlike a broad squat goblet. It has a fanciful scalloped edge and comes in crystal, green, amber, and rose. Justin Tharaud, Inc., has put on the market a gold decorated dinner ware with floral centers. The edge is scalloped with a gold line and inside of this is a narrow line in red, blue, or green. The gold print which extends toward the center has a fanciful stalactite effect. E.P.R.

China and glassware. ANON. *Pottery Glass & Brass Salesman*, **41** [16], 17 (1930).—Heinrich & Winterling, Inc., have added to their ivory body a narrow band of a rich green tone made interesting by oblique lines in a darker shade of green. At regular intervals are floral urns, flanked with spray-like floral treatments in pink, purple, yellow, and light green. Edge line and handle trimmings are in gold. Horace E.

Gray Co., has the latest European idea in flower containers in a round crystal bowl flat on the bottom. The stems are rendered attractive by curves in the glass. Edwin Bennett Pottery Co., has some examples of the famous old blue willow pattern done in underglaze prints in blue, pink, etc., also an old time chintz all-over pattern. Unlike the blue willow it is shown on an ivory body in a range of four colors, red, green, blue, and black. Dunbar Flint Glass Corp., has a very extensive line of tumblers in pink and green glass. The Edmondson Warrin, Inc., are providing novelties in monogram work applied to china and glassware. E.P.R.

Gifts in china and glass. ANON. *Pottery Glass & Brass Salesman*, **41** [14], 17 (1930).—The Crooksville China Co. has brought out a border pattern which is half an inch in width, featuring a maroon as a ground color with yellow making for a relief ground color. Scroll work is in a golden color. At regular intervals blue medallions are set with a single rose. The decoration is completed with a gold shoulder. The Liberty Works has a new line of black tableware. Morgantown Glass Works has produced a new line of black plated glassware cut in an attractive design. The black has an unusual effect as the skin is blown on at a high degree of thinness. Edwin M. Knowles China Co. has a new body called "Mayglow" which is a soft creamy peach-colored body. The decorations run to floral effects and range in colors from a vivid green to a soft orchid. E.P.R.

Gifts in china and glassware. ANON. *Pottery Glass & Brass Salesman*, **41** [17], 23 (1930).—Wm. S. Pitcairn Corp. have two new patterns applied to the Windsor shape. The "Fairfield" is a riot of gay colors with grass green predominating, but relieved with yellow, blue, and red. The "Oakland" has a band in blue edged with gold and yellow. The motifs consist of baskets of enameled flowers in yellow, pink, blue, and green. The Schumann China Corp. have a variety of new dinnerware decorations, including the Dresden style and others of a modern mode. E.P.R.

Seasonal offerings in china and glass. ANON. *Pottery Glass & Brass Salesman*, **41** [13], 17 (1930).—Theodore Haviland & Co., has a modernistic pattern on dinner ware designed by Suzanne Lalique. An outstanding feature is the employment of short wave blue hair lines placed close together. Within the center is a motif sketchily done in platinum on black. The Imperial Glass Co. has a new line of fancy tableware in black glass carrying a heavily etched design. A narrow edge in bright silver gives a contrast to the black. The A. E. Hull Pottery Co. is displaying a new "Exeter" shape in English rock teapots. The pot is almost square in the upper portion and squat in the lower. It is shown in a variety of decorative treatments adorned with black and colored figures. Corning Glass Works has produced a three layer glass known as "Intarsia." This line is semi-utilitarian to semidecorated. The shapes are in crystal glass and the stem is cased with a thin skin of black cut out in odd designs. They are also showing a line of vases made in crystal glass and ornamented in a stippled treatment in line blue and opal. A new color patch has been added to their line known as "Celadon" which is an odd shade of green. E.P.R.

New design in glassware. ANON. *Pottery Glass & Brass Salesman*, **41** [15], 23 (1930).—Hocking Glass Co. is putting out luncheon sets made of green colored glass known as the "Vogue." E.P.R.

New Princeton windows. CHARLES J. CONNICK. *Amer. Mag. Art*, **20** [10], 564 (1929).—C., designer and worker in stained glass, has completed the first of a series of windows for the chancel of Princeton University Chapel. Measuring 16 by 42 ft., it depicts scenes from Dante's Divine Comedy. Three others follow, Paradise Lost, Pilgrims Progress, and Morte d'Arthur. E.B.H.

Problems in the installation and application of mobile color lighting for decoration. M. MESSNER. *Trans. Illum. Eng. Soc.*, **25**, 292–99 (1930).—M. gives a brief review

of the events leading up to this outstanding installation of Colorama lighting, and a description of the construction and operating characteristics of the system. M.A.B.

Illustrations. ANON. *Studio*, **96** [397], 19 (1930).—Photos of three symmetric bowls from France showing primitive feeling and of modern Sèvres porcelain, a plate in gray, white, and brown, and a vase of white with yellow shadows. E.B.H.

Mountain pottery of North Carolina. R. CARL MOORE. *Ceram. Age*, **14** [5], 178 (1929).—A description of some handmade art pottery, being produced in North Carolina. W.W.M.

Spode's contribution to English pottery. RONALD COPELAND. *Pottery Gaz.*, **55** [636], 1002 (1930).—The two great standards which Spode raised in the Potteries were blue-printed ware and bone porcelain. While Wedgwood is praised justly for his work, it is to Spode that one turns when thinking of commercial tableware of the highest order. E.J.V.

Art and technical progress in the potteries. ANON. *Pottery Gas.*, **55** [636], 970–76 (1930).—The celebration of 200 years of progress in connection with the manufacture of pottery calls to mind very specially what has been done in recent years on both the art and technical sides of the pottery industry, with a view to enabling the British potters to hold up their heads as leaders in the field of ceramics. In this review of the past thirty or so years the topics discussed are technical progress; the Ceramic Society, the pioneer investigators, the work of Mellor, the growth of the Ceramic Society, international meetings, the Pottery College at Stoke, efficiency of kilns, training students, progress in ceramic art, and the local art schools. Illustrated. E.J.V.

Pottery at the Royal Academy. ANON. *Pottery Gaz.*, **55** [636], 963 (1930).—Among the pieces of pottery on exhibition at the Royal Academy this year are statuettes executed in terra cotta by Winifred Turner, called "Diana"; a group in glazed earthenware by S. Nicholson Babb, entitled "The Wine-God's Festival," and another glazed earthenware group entitled "Sheba's Queen"; and "Europa," a group in glazed earthenware by Donald Gilbert. Some paintings into which pottery or glassware are introduced are also described. E.J.V.

Retrospective exposition of ceramic art. GOLDA M. GOLDMAN. *Ceram. Age*, **14** [6], 220–24 (1929).—An article on a recent International Exposition of Decorative Arts, at Paris, comparing 19th and 20th Century ceramic ware and art displayed, with mention of the artists. The trend in French ceramic art is discussed. W.W.M.

Program of summer courses at Faenza on the history of medieval and modern Italian ceramics. June 29 to July 13, 1930. ANON. *Corriere ceram.*, **11** [4], 157–61 (1930). M.V.K.

Gablontz industry. ANON. *Rev. belge ind. verrières*, **1**, 52–53(1930).—A description of Gablontz ware and its manufacture is given. A.J.M.

BOOKS

Corning's development as glassware center traced in "American Arts." ANON. *Amer. Glass Rev.*, **49** [34], 14 (1930).—The development of glassmaking in this country is interestingly discussed in a book by Rilla Evelyn Jackman of Syracuse University, entitled "American Arts." E.P.R.

Aegyptiaca. J. D. S. PENDLEBURY. Foreword by H. R. Hall. 5 plates and 3 maps. University Press, Cambridge, 1930. Price 5s. A catalogue of all the Egyptian objects found in the Aegean area down to the close of the 26th dynasty. H.H.S.

Catalogue of Schreiber Collection of English Porcelain, Earthenware, Enamels, and Glass. Vol. II. **Earthenware.** BERNARD RACKHAM. Revised ed. xii + 139 pp., 86 plates. Victoria and Albert Museum, London, 1930. Price 6s 6d. The Schreiber collection was presented to the V. & A. Museum in 1884. This volume completes the revised edition in 3 vols. of the catalogue originally published in 1885. H.H.S.

Faience of Braunschweig. (Braunschweiger Fayencen.) CHRISTIAN SCHERER. E. Appelhans and Co., Braunschweig, 1929. 76 pp. 48 illustrations. Reviewed in *Sprechsaal*, **63** [20], 376 (1930).—The first part of the book contains the history and description of the two faience factories in Braunschweig which played an important part in developing the German faience art during the 18th Century. The second part of the book is a catalogue of the State Museum of Braunschweig which has a large collection of artistic faience pieces. M.V.K.

Dress and Ornaments in Ancient Peru. GOSTA MONTELL. Translated from the Swedish. viii + 262 pp. Oxford Univ. Press, 1930. Price 15s. Reviewed in *Times Lit. Supp.*, **29** [1463], 113 (1930).—Pottery, the finest ever produced by people unacquainted with the wheel, was manufactured in large quantities centuries before the Incas, at two centers, Truxillo in the north and Nasca in the south. This pottery is an encyclopedia of dress and ornament. H.H.S.

Corpus Vasorum Antiquorum: Vols. 3, 4, 5, 6, 8, 9. E. POTTIER, H. B. WALTERS, C. BLINKENBERG, AND K. F. JOHANSEN. H. Champion, Paris, and H. Milford, London, 1930. Price 17s 6d each for Vols. 3, 5, 6, 8, 9; 12s 6d for Vol. 4. Reviewed in *Times Lit. Supp.*, March 13, 1930.—This undertaking of the Union Académique Internationale has steadily pursued its appointed course. Vols. 5, 6, 8, 9 cover ancient vases in France, Vol. 3 those at Copenhagen National Museum, and Vol. 4 those in the British Museum. H.H.S.

Decorated Architectural Terra Cottas of Corinth. IDA THALLON-HILL AND LIDA SHAW KING. Harvard Univ. Press, Cambridge, Mass., 1930. Price $5.40. Reviewed in *Times Lit. Supp.*, Feb. 6, 1930.—Vol. IV, Pt. 1 of the report on the excavations at Corinth by the American School of Classified Studies at Athens. H.H.S.

Old English Tobacco Jars. REGINALD MYER. With preface by Charles R. Beard. Sampson Low & Co., London, 1930. Price 15s. H.H.S.

Greek vases in Poland. J. D. BEAZLEY. Clarendon Press, Oxford, 1930. Price 2 guineas. Reviewed in *Times Lit. Supp.*, March 13, 1930.—The study of Greek vases has been revolutionized by B., who has been able to identify a number of masters and to assign to them definite groups of vases. H.H.S.

PATENTS

Design for plate. JOHN KIRKPATRICK. U. S. 81,293, June 3, 1930.

Design for goblet, etc. GEORGE SAKIER. U. S. 81,301, and 81,302, June 3, 1930.

Design for tray, etc. WILL CAMERON MCCARTNEY. U. S. 81,309, June 3, 1930.

Art clay. JOHN P. SLINGER. U. S. 1,763,105, June 10, 1930. An art clay comprising a mixture of approximately 40 parts of whiting, approximately 14 parts of talc, approximately 20 parts of dextrine, approximately 10 parts of liquid glucose, and sufficient formaldehyde and sandalwood oil to preserve and color the clay, together with enough water to form a paste.

Coloring ceramic and metal articles. DEUTSCHE GOLD-UND-SILBER-SCHEIDEANSTALT VORM. ROESSLER. Fr. 674,595, March 16, 1929. Ceramic or metal objects are given a layer of coloring material and then a layer of a solution containing glycerol or other substance having a high surface tension and colloids such as gum arabic and preferably also cane sugar. The objects are then baked. (*C.A.*)

Cement, Lime, and Plaster

Effect of boric acid on the clinkering of Portland cement. ANON. Bur. Stand., *Tech. News Bull.*, No. 157, p. 46 (1930).—An investigation to determine the possibility of producing a well-burned clinker at a relatively low temperature by the use of a small

quantity of boric acid as a flux was begun at the Bureau several months ago. Heating curves were studied to determine energy changes of mixtures of $CaCO_3$ and SiO_2 in the ratio of 2 parts of calcium oxide and one of silica (dicalcium silicate). Evidence was obtained of (1) an exothermic reaction at about 1420°C and (2) an endothermic reaction immediately following. The first reaction is thought to be the formation of dicalcium silicate and the second the inversion of β dicalcium silicate to the α form. The first reaction is not affected by the addition of small quantities of boric acid to the raw mixture but the second was found to occur at progressively lower temperatures with increasing amounts of boric acid. R.A.H.

Lime-silica index. HAROLD H. STEINOUR. *Rock Prod.*, **33** [11], 81 (1930).—S. points out the advantage of multiplying the lime-silica index by the factor 1.07 to obtain the molecular ratio of lime to silica. From this molar index the amount of tricalcium silicate can be found. In cements fired to equilibrium, if the molar index is 2.00 there will be only dicalcium silicate present (since only di- and tricalcium silicates are considered). If the molar index is 3.00 only tricalcium silicate is present. The molar index is usually between 2.00 and 3.00. If it is 2.40 there is 0.40 mol. of $3CaO \cdot SiO_2$ and 0.60 mol. of $2CaO \cdot SiO_2$; if 2.60, there is 0.60 mol. $3CaO \cdot SiO_2$ and 0.40 mol. $2CaO \cdot SiO_2$, etc. If it is over 3.00 there is free lime present. W.W.M.

Researches on the syntheses and hydration of calcium aluminates. IV. S. NAGAI AND R. NAITO. *Jour. Soc. Chem. Ind.* [Japan], **33** [1], 17B–19B (1930); *Tonind.-Ztg.*, **54** [25], 436 (1930).—Having determined the temperatures at which $3CaO \cdot 5Al_2O_3$, $CaO \cdot Al_2O_3$, and $5CaO \cdot 3Al_2O_3$ are formed, the authors extended their researches on tricalcium aluminate keeping the same experimental methods. The results are summarized in the following table:

Temp. in °C	Time in min.	Pure lime (%)	Pure alumina (%)	Combined lime (%)	Combined alumina (%)	Molar proportion of CaO/Al_2O_3
950	120	59.4	30.7	2.0	7.0	0.76
1100	60	52.6	22.7	9.7	15.0	1.17
1250	60	47.3	17.5	15.0	20.2	1.36
1350	60	32.0	4.4	30.3	33.3	1.66
1350	60	30.0	4.5	31.6	33.2	1.73
1400	180	4.5	0.2	37.8	37.5	2.81
1450	180	19.9	1.7	43.4	36.0	2.14
1500	180	4.9	0.4	58.0	37.3	2.80
1500	180	0.04	0.1	62.3	37.6	3.02
1550	60	0.2	0.03	62.1	37.7	3.01

A diagram of the results shows not only the origin of the single aluminates at different temperatures but also the quantity at which the intersection of the single aluminates appears. See also *Ceram. Abs.*, **9** [3], 154 (1930). M.V.K.

Lime satiation ratio of Portland cement. S. RORDAM. *Rock Prod.*, **33** [12], 82 (1930).—The major constituents of Portland cement are $3CaO \cdot SiO_2$, $2CaO \cdot SiO_2$, $4CaO \cdot Fe_2O_3 \cdot Al_2O_3$, and $3CaO \cdot Al_2O_3$. If a cement contained the maximum amount of lime the $2CaO \cdot SiO_2$ would be absent, leaving only the other three compounds. The ratio of the amount of lime actually present to the amount required to give only these three compounds, R calls the "lime satiation ratio." Taking the chemical analysis, each 1% SiO_2 combines with 2.8% CaO to form $3CaO \cdot SiO_2$; each 1% Fe_2O_3 combines with 0.64% Al_2O_3 and 1.4% CaO to form $4CaO \cdot Fe_2O_3 \cdot Al_2O_3$; each 1% of the remaining Al_2O_3 combines with 1.65% CaO to form $3CaO \cdot Al_2O_3$; each 1% SO_3 combines with 0.7% CaO to form $CaSO_4$. Combining these factors we get the formula:

$$\frac{\%\ CaO - SO_3 \times 0.7}{\%\ SiO_2 \times 2.8 + \%\ Fe_2O_3 \times 0.34 + \%\ Al_2O_3 \times 1.65} = \text{L.S.R.}$$

This is always less than one but approaches one for quick-hardening cements. W.W.M.

Research on hydrated polycalcium aluminates. ANON. *Ciment*, **34**, 8 (1929); *Rock Prod.*, **33** [6], 82 (1930).—Travers and Schnoutka have already indicated the preparation of the pure hydrated tricalcium aluminate $Al_2O_3 \cdot 3CaO \cdot 21H_2O$, crystallized in needles, starting from the solution of potassium aluminate and nitrate of lime. Investigations showed them that the zone of p_H concentration, in which these crystals precipitate in a pure state, is between p_H 11.57 and p_H 11.62. If the medium is more alkaline, distinctly different shapes of crystals are observed. Between p_H 11.62 and p_H 11.79, there results crystals grouped in spherolites analogous to those indicated by Le Chatelier; between p_H 11.79 and p_H 11.89, there are formed exclusively crystals which are characteristically hexagonal, analogous to those described by Allen and Rogers. Beyond p_H 11.89, there is observed at times the formation of hexagonous crystals, and of rhombohedrons of lime ($Ca(OH)_2$). On analysis of these various kinds of crystals, which are possible in a single phase, and by placing them in the exact conditions indicated, it was found that they all contain more lime than tricalcium aluminate and that the proportion of lime can vary from 3 to 4 CaO per Al_2O_3, despite identity of crystalline form. The spherolites of Le Chatelier have an exact composition of $Al_2O_3 \cdot 3.75CaO$, this authority giving them, however, the formula of tetra calcium aluminate. The variation of the proportion of lime, with an identical crystal form, led to the belief that these are solid solutions of lime and of an aluminate of lime. Experience has shown that this is not the case. On rapid leaching with $N/10$ HCl the lime is dissolved quicker than the aluminate, so that at the end of a number of leachings the residue always corresponds to the composition of the existing aluminate, and finally the residue itself may be entirely dissolved. Constructing a diagram, in which the ordinates are the lime dissolved in a given leaching, and the abscissas, the alumina dissolved in the same test, it is found that the points representative of the part attacked are along a straight line having as angular coefficient the one of tricalcium aluminate, whatever be the crystalline form studied (spherolites or hexagonals). Therefore it is evident that we are concerned with the solid solution of $Ca(OH)_2$ in hydrated tricalcium aluminate. According to the p_H concentration of the solution, the aluminate or the lime have their own respective crystalline systems. These tests make doubtful the existence of the hydrated bicalcium aluminate described by Allen and Rogers and by Lafuma. Though the actual hydrate $Al_2O_3 \cdot 2H_2O$ has been made, the bauxite detected in the analysis by X-rays and in the thermal analysis, is a mixture of $Al_2O_3 \cdot H_2O$ and of $Al_2O_3 \cdot 3H_2O$ and not the hydrate with two molecules of water. The study of the proportion of these hydrated aluminates is of a very great importance by reason of application to the alumina cements. W.W.M.

Iron oxide vs. alumina as a fluxing agent in manufacture of Portland cement. KATSUZO KOYANAGI. *Rock Prod.*, **33** [10], 82–83 (1930).—After several months of experiments, K. concludes that in the case of a cement high in silica and low in alumina, both iron oxide and alumina act as fluxing agents to further fuel economy, but the alumina is more advantageous from the standpoint of cement quality. High iron oxide content not only lowers the tensile and compressive strengths but makes the cement unsound. K. states that when a cement is high in alumina and low in silica, iron oxide can be used advantageously as a flux, but when the silica content is high and the alumina low it is better to increase the latter than to add iron oxide. W.W.M.

Action of silico-fluorides on cement and concrete. E. GRÜNER AND U. WERTHER. *Z. angew. Chem.*, **42** [50], 1133–37 (1930); *Tonind.-Ztg.*, **54** [6], 107 (1930); *Rock Prod.*, **33** [6], 82 (1930).—Zinc and magnesium silico-fluorides are often added to concrete to increase its density. The action of such fluorides is expressed by the following relation:

$$3Ca(OH)_2 + Me''SiF_6 \longrightarrow 3CaF_2 + Si(OH)_4 + Me(OH)_2$$

whereby the SiO_2 of the residue should increase and the CaO remain constant since CaF_2 is precipitated. Varying amounts of the fluoride were added to a series of cements and following a period of storage the cements were analyzed. The amount of CaO present had diminished due to the presence of $CaCO_3$ and $CaSO_4$ which reacted thus:

$$CaCO_3 + ZnSiF_6 \longrightarrow CaSiF_6 + ZnCO_3.$$

$$CaSiF_6 + 3Ca(OH)_2 \longrightarrow 3CaF_2 + Si(OH)_4 + Ca(OH)_2$$

so that probably some CaO remained in solution. There were increases in the amount of SiO_2, ZnO, MgO, and F which agreed with the theoretical considerations. When an excess of fluoride was added the compressive strength decreased; when one molar zinc or magnesium silico-fluoride was added the strength was practically zero. A very small amount ($^1/_{20}$ to $^1/_{10}$ molar solution) increases strength. Small amounts added to the cement decreased permeability while greater concentrations increased permeability. Thus if there is an excess of silico fluoride over that of CaO as required by equation I there is a harmful effect produced. L.T.B.

Determination of sucrose soluble CaO in Portland cement. T. F. SEDGWICK. *Rock Prod.*, **33** [11], 81 (1930).—S. believes that the method for determining sucrose soluble CaO in burned and hydrated lime gives a fair index to the amount of free CaO in cements. He used a modification of the Bureau of Standards and Hawaiian Sugar Planter's Assn. methods to test several cements. Fresh samples showed about 4% sucrose soluble CaO, while after exposure to air, allowing the free lime to form carbonate, about 0.2% sucrose soluble CaO was found. W.W.M.

Alumina cement. HAEGERMANN. *Tonind.-Ztg.*, **54** [23], 393–95 (1930).—The following reasons are given for the heretofore limited use of alumina cements in Germany, in spite of the exceptional properties of this cement and the excellence of the German made product. The high price in comparison with ordinary concrete and ferro-concrete forces building contractors to use it only in very special cases and even then to attempt the substitution of Portland cements of high quality. The necessity of importing the raw material, bauxite, used in the manufacture of alumina cements and the special difficulties of manufacture are additional obstacles to the use of alumina cements. A comparison of the composition of alumina cements with Portland cements shows the former to permit much greater variations in the per cents of the ingredients. M.V.K.

Zinc cements. A. A. SHCHUKIN. *Ukrainskii Khem. Zhur.*, **4**, Sci. Pt., 285–91 (1929).—ZnO is added to $ZnCl_2$ solution in such quantity that the total Zn present in solution is equal to that contained in the ZnO. The mixture is, for several days, alternately shaken and allowed to rest, and then filtered; a clear solution is obtained, which finally solidifies. The solid is a mixture of the cement (oxychloride) and some of the original substances. (*C.A.*)

Hardening of Sorel cements. A. KRIEGER. *Tonind.-Ztg.*, **54** [34], 577–78 (1930).—Sorel cement prepared from the magnesite of Greece was investigated. The $MgCl_2$ was determined by alcoholic extraction. It w s found that the paste can be heated to boiling without affecting the results as the oxychloride is not decomposed by boiling alcohol. After filtering, the filtrate was found to contain uncombined $MgCl_2$ and free H_2O. The residue consists of the combined water, $MgCl_2$, $Mg(OH)_2$, MgO, impurities of magnesite, and sand. The $Mg(OH)_2$ content can be calculated from the loss on ignition and is 13.93%. Examples are given which show the exactness of the values. It is not possible to establish a formula for the oxychloride compounds by this method or to fix what quantity of $Mg(OH)_2$ goes in double combination with $MgCl_2$. By specific tests the proportion of $MgCl_2$:$Mg(OH)_2$ from 1:3 up to 1:15

was established. Comparative tables show the changes in content of waters, etc., of a slightly fired magnesia and a Euböa magnesite after 3, 5, 8, and 28 hrs. hardening. The problem was to determine whether the beginning of hardening depends on the $Mg(OH)_2$ or oxychloride formation. After 5 hrs., the magnesium mortar has a higher content of combined $MgCl_2$; while the content of $Mg(OH)_2$ is higher in magnesite. As the magnesium mixture is already hard at this stage and the magnesite is still soft, it can be concluded that the beginning of hardening is caused by the formation of oxychloride. M.V.K.

Magnesia cements. ANON. *Ciment*, **34** [12], 613–16 (1929); *Rock Prod.*, **33** [9], 80 (1930).—The general composition and conditions encountered in the use of magnesia cements are discussed in detail. W.W.M.

Gypsum plaster in the ceramic industries. J. E. WISS, T. P. CAMP, AND R. B. LADOO. *Rock Prod.*, **33** [12], 62–68 (1930); for abstract see *Ceram. Abs.*, **9** [6], 411 (1930). W.W.M.

Gypsum burning. MARTIN. *Tonind.-Ztg.*, **52** [63], 1278–79 (1928); *Rock Prod.*, **33** [7], 82 (1930).—M. describes the process and products of gypsum burning and shows a few gypsum kettles and kilns, which he considers typical. One is a gypsum chamber kiln in which crushed but not reground gypsum rock is placed on the iron sheeting of trucks which are pushed into the kiln chambers. The kiln gases do not come in contact with the gypsum, but pass around the burning chamber in the ducts. After reaching the desired burning temperature, the kiln is "soaked" a few hours to allow uniform heat distribution. The kiln can be charged four times a week and has a coal consumption of 9 to 12.5 T. per 100 T. of burned gypsum. M. considers the rotary gypsum kilns like the Cummer, the Polysius, and the Buettner, too expensive of installation and too large in capacity for the European gypsum works, in spite of their advanced technical and economic features. Therefore, in the production of stucco gypsum, gypsum kettles are usually employed. In these kettles, placed on a brick setting, a rotary agitator or rabble moves the gypsum rock constantly while the heat is applied around the kettle. The coal consumption is about 7.5 T. per 100 T. of burned gypsum. Estrich gypsum is usually burned in mixed-feed shaft kilns. The fuel consumption is about 7 T. of coal per 100 T. of burned gypsum, for a typical installation. The Meier shaft kiln for providing Estrich gypsum has a rectangular cross-section, but is not of the mixed-feed type, the fuel being burned in two special chambers located at opposite sides outside of the gypsum burning shaft. No ashes and slag contaminate the plaster gypsum being produced. The gypsum rock which is charged at the kiln top, is preheated by the discharging combustion gases. The burned gypsum is drawn at two discharges at the base. Openings are provided in the kiln to permit observance of the progress in the burn. The fuel consumption of the Meier kiln is about 8 T. of coal per 100 T. of burned gypsum. W.W.M.

Mining and treatment of gypsum at South Australian plant. L. J. WINTON. *Pit and Quarry*, **19** [5], 43 (1930).—The Waratah Gypsum Co. Pty., Ltd., operates a modern gypsum grinding and calcining plant that produces around 850 T. of plaster weekly, representing the output of three kettles. The raw material is obtained at Lake McDonnell and is transported to the mill. E.P.R.

Effect of fine grinding and water content on cement strengths. HANS KÜHL. *Pit and Quarry*, **20** [5], 61–66 (1930).—The addition of an accurately-measured quantity of water is an important requirement in testing cements. A slight variation in the water added has a marked effect on the strength tests. The relation between the strength characteristics of the cements, their degrees of fineness, and the water contents of the testing mixtures is shown in a series of curves. A relation exists between the course of the grinding curves and the water requirements of the cements, which affords

a practical substantiation of the theoretical assumption, *i.e.*, that the water requirements for standard consistency in the case of well sintered and freshly-ground Portland cements must increase in parallel with the degree of fineness independently of the chemical composition of the cements. The result is that a gel is formed which is constantly increasing in water content and also becoming softer and softer, as larger amounts of water are added. Inasmuch as the same quantity of coarse constituents of the cement must always be available for the phenomenon of "internal suction," the addition of larger amounts of water must not only have a deleterious action on the process of hardening, but this action must also be manifested to a greater degree, the smaller the proportion of coarser constituents in the cement, which has to carry out the phenomenon of "internal suction" and therewith cause the hardening of the cement. It appears that there is a definite law relating to the size of the particle of the cement similar to the one that Fuller and Graf have found to apply to the size of particles of concrete. E.P.R.

Testing cement. HANS KÜHL. *Cement and Cement Mfg.*, **3**, 31 (1930).—A discussion of methods of testing Portland cement and the evolution of cement specifications. The need for separate standard specifications for each building material is emphasized. Specifications for specific gravity and weight per liter are considered obsolete. K. suggests that in the future specifications will limit the proportion of the most finely-ground particles rather than the maximum residue on sieves of coarse mesh. Cements which meet the strength specifications are certain to be ground fine enough, while cements which are ground too fine show decreasing strength when stored, and are more sensitive to increased water content than are the more coarsely-ground cements. The use of tensile strength tests with plastic mortars as the best indication of the utility of the product is advocated. The preparation of the test specimens should be mechanized as far as possible to insure uniformity of results. The work of Gensbauer and Prüssing is cited as indicating a relation between compressive strength, tensile strength, and soundness, which if confirmed by further research may lead to new specifications for the strength and soundness of cements. This relation is also indicated by changes in the lime content of the raw mix. Increasing the lime content up to a certain value increases both tensile and compressive strength; when this lime value reaches a certain limit the compressive strength still increases but tensile strength decreases. Further increase of the lime content results in decreased compressive strength and apparent unsoundness. W.L.

Recent Japanese research in Portland cement. WILLIAM A. ERNST. *Rock Prod.*, **33** [12], 79–81 (1930).—A review covering research on formation and hydration of calcium aluminates, small-piece testing on strength of cement mortar and cement studies on mixed Portland cements. Formulas, data, and tables are included. W.W.M.

Modern cement-testing laboratory. ANON. *Rock Prod.*, **33** [12], 75–76 (1930).—The Southwestern Portland Cement Co., El Paso, Texas, has a new laboratory in which noisy machinery is muffled and the moist room is kept near 100% humidity and within 1 °F of 70 °F the year round. There are some unique arrangements described and illustrated. W.W.M.

Disintegration of cement clinker. JEAN MUNDORF. *Tonind.-Ztg.*, **54** [35], 594 (1930).—A clinker composed of 40% blast-furnace slag and 60% limestone proved to be worthless and after a short time crumbled to powder. An analysis of the blast-furnace slag showed a content of up to 8% metallic Fe besides the 4 to 5% FeO. The great content of iron caused premature vitrifying and an over-firing of the clinker. The coke used did not oxydize but reduced as an oxygen atom was taken from FeO to reduce the metallic Fe. The analysis showed an increase of glow conditioned by the oxi-

dizing of the metallic Fe or FeO to Fe_2O_3. Likewise sulphide was found. The presence of fine iron splinters and grains in the decomposed clinker could be ascertained with a magnet. As the metallic Fe as well as FeO does not combine with CaO of the clinker, a surplus of lime appears which lowers the solidity and produces the blowing of cement. M.V.K.

Volume constancy of cements. HANS KÜHL. *Tonind.-Ztg.*, **54** [17], 278–81 (1930).—In all countries the standard requirements for absolute volume constancy of cements are (1) resisting cold water for 28 days, (2) boiling tests, and (3) meeting the special specifications for sulphuric acid and magnesia contents. In spite of these requirements there is not a single cement which is really constant in volume. Gensbaur found great decreases in the solidity of cement samples which were hardened in air and stored in water. Haegermann found the same with natural rocks as limestone and granite. K. describes his own tests with Portland cements and gives tables which show their solidity and tension after Kl (combined) storing and alternate storing (three days water and three days air). The great irregularities in the solidity figures can be ascribed to chemical causes and tensions in the inner structure of the cement. The chemical processes going on belong to the sphere of capillary chemistry. M.V.K.

Influence of sugar on setting and hardening of Portland cement. H. W. GONELL. *Zement*, 1929; *Pit and Quarry*, **19** [3], 44–46 (1929); for abstract see *Ceram. Abs.*, **9** [4], 256 (1930). E.P.R.

Storing cement. A. PELLACINI. *Corriere ceram.*, **11** [3], 101–103 (1930).—P. urges all Italian industrialists to adopt the method of storing clays from 48 hrs. to 15 days or longer, to improve the quality. Two methods of preparation for storing are given. M.V.K.

Effect of storage on cements. HAEGERMANN. *Pit and Quarry*, **19** [3], 112 (1929); for abstract see *Ceram. Abs.*, **9** [3], 157 (1930). E.P.R.

Phenomena occurring in sacked cement. ANON. *Tonind.-Ztg.*, **53** [102–103], 1791–93 (1930); *Rock Prod.*, **33** [10], 94 (1930); see also *Ceram. Abs.*, **9** [2], 85 (1930) article by GOSLICH and article by LUFTSCHITZ, *Ceram. Abs.*, **9** [5], 333 (1930). W.W.M.

Observations on accelerated soundness tests. A. T. GOLDBECK. *Pit and Quarry*, **19** [3], 47–54 (1929).—Tests on a number of materials and by various methods are discussed in detail. E.P.R.

Causes of concrete disintegration. F. R. MCMILLAN. *Eng. News Rec.*, **104,** 735 (1930).—In a reply to T. Merrimans paper on "Durability of Portland Cement," (see *Ceram. Abs.*, **9** [7], 500 (1930)), numerous illustrations are given showing the failure of certain portions of structures in which the failures are clearly the result of improper methods of placing the concrete and are not due to the quality of the cement. The sugar solubility test which Merriman proposes seems to be quite useful in determining the resistance of different cements to the action of sodium sulphate. There is as yet no proof, however, that the behavior in the sodium sulphate solution is any indication of the performance which may be expected of the cement under normal concrete use. There is every reason to believe from the experience of the past that practically all of the cements if properly used, are capable of producing durable structures. W.L.

False set of Portland cement. D. K. MEHTA. *Cement and Cement Mfg.*, **3,** 306 (1930).—M. does not agree with the theory that false set is due to high temperatures in the finishing mills. The temperatures in the finishing mills in India vary from 230 to 300°F, and normal setting products are obtained. He believes the false set to be due to incorrect temperatures in the kiln and that the false set of an underburned clinker may be accentuated by the high temperature in the finishing mill. W.L.

Influence of trass on the setting time of cements. A. STEOPOE. *Tonind.-Ztg.*, **54** [15], 237–39 (1930); *Rock Prod.*, **33** [10], 94 (1930).—The purpose of this work was

to study the properties of Rumanian trass as their chemical composition is rather different from the foreign trass. (1) The influence of trass admixtures on the setting of cements depends on the nature of the cement and of the kind of trass. (2) In general, trass admixtures retard the setting of Portland cements, but their action is less on a Portland cement of high qualities, than on an ordinary Portland cement. The beginning of the hardening of Kühl cements is hastened by admixtures of trass, while the end of hardening is retarded by small admixtures; or, at first hastened by large additions, then again greatly retarded. M.V.K.

Influence of the duration of stirring and of the additions of trass on the resistance to pressure of liquid cement mortar. A. Steopoe. *Tonind.-Ztg.*, **54** [35], 590–91 (1930).—The following materials were used for these tests: (1) ordinary Portland cement, (2) high quality Portland cement, and (3) Kühl cement. Mortars were prepared from equal parts by weight of cement and sand and 25% water, stirred slowly and continuously for 5, 80, and 170 minutes, then poured in forms, and left for 24 hrs.; stored for 24 hrs. in a space saturated with steam, then in water for 5 days. After this the cubes were weighed with steam, then in water for 5 days. After this the cubes were weighed and tested by pressure on lateral surfaces. Cements containing 25% trass and 28.5% water were similarly treated. An electric blunger was used. The results showed that: (1) Mortar of pure Portland cement (ordinary and high quality) shows the highest resistance to pressure after 80 minutes stirring and the lowest after 170 minutes. (2) Resistance to pressure of mortars of Kühl cement decreases with stirring. (3) Mortars of Portland cement (ordinary or of high quality) with an admixture of 25% trass act the opposite of pure cement as the resistance to pressure is lowest after 80 minutes stirring. (4) On the other hand, mortars of Kühl cement with a 25% addition of trass have the greatest resistance to pressure after 80 minutes stirring. Conclusions: The influence of the length of stirring on the resistance to pressure of liquid mortars depends on the kinds of cement and their admixtures. M.V.K.

Silicate material vs. trass for cement and lime. R. Menser and Luftschitz. *Zement*, **18** [49], 1411–15 (1929); *Rock Prod.*, **33** [11], 91 (1930).—M. and L. have a controversy about the use of silicate material as compared to trass in the preparation of mortars for building dams across valleys. The discussion centers about strength relative to water content and change in volume of the mortar. W.W.M.

Railroad box car with Haydite concrete floor. Anon. *Rock Prod.*, **33** [12], 74 (1930).—The wooden floor of a box car was replaced with 4 in. thick Haydite concrete at a cost of 35¢ per square foot. It is stronger and more resistant to wear than is wood and makes for ease of loading and unloading, especially in case of bulk shipments. W.W.M.

Dry and wet cement processes. Henri Pooly. *Cement and Cement Mfg.; Le Ciment*, July, 1929; reviewed in *Pit & Quarry*, **18** [12], 111 (1930).—A comparison was made of the yield of Portland cement and the coal consumption by the dry and wet processes. The kilns produced 10 T. per hour. In a works using the wet process, the kiln and cooler had a total length of 280 ft., the diameter being 8 ft., except the sintering zone which was 10 ft. The fuel consumption per ton of cement was 36 lbs. In a plant using the dry process in a kiln 220 ft. long, comprising a cooler $6^1/_2$ ft. wide, the sintering zone being 10 ft. in diameter, the fuel consumption was 21.75 lb. per ton of cement. The advantage remains strongly with the dry process. E.P.R.

Analyses of waste gases of rotary cement kilns and their part in kiln control. Alton J. Blank. *Rock Prod.*, **33** [10], 58–60 (1930).—B. cites an application of the "Arkon" recorder, an apparatus for analyzing and recording the carbon dioxide and oxygen contents of waste gases. It is a water-driven instrument. Gas samples are taken

continuously through a pipe which projects a few feet beyond the feed ring into the kiln. This apparatus uses the same gas absorbents as does the Orsat, and may be set to record automatically the percentages of carbon dioxide and oxygen from five to ten times per hour. The solutions in the "Arkon" instrument must be renewed about once a week. A piece of silver foil placed under the discharge water pipe of the apparatus will turn brownish-black if carbon monoxide is present in the gases. B. shows the effect on fuel consumption of the presence of excess oxygen or carbon monoxide in the waste gases and points out the advantage to the industry of waste-gas analyses.

W.W.M.

Developments in cement kilns. C. NASKE. *Z. Ver. deut. Ing.*, **74**, 1 (1930); *Rock Prod.*, **33** [7], 82 (1930).—N. describes rotary cement kilns in which the waste gases are utilized for firing steam boilers and for drying the crushed raw material; cellular coolers, compartment mills, feeding and control apparatus for pulverized coal; and the modern automatic shaft kiln with two blowers and divided air supply. Reclaiming of waste heat from clinker, injection of air preheated on the chamotte lining of the kilns into the kiln as a secondary air, and suitable treatment of the raw material are discussed.

W.W.M.

Influence of ash and flue dust on cement. A. WEISSMANN. *Tonind.-Ztg.*, **54** [33], 563 (1930).—During W.'s work in China in a cement plant using the wet process he had great difficulties in obtaining a good average cement. The irregularities were ascribed to the flue dust being added directly to the slip in the kiln entrance. W. found a mass of raw powder, ash, and flue dust in the form of powder in an apparently well-fired clinker. This flue dust did not mix with the slip and formed lumps. When thoroughly mixed to a homogeneous mass the clinker had the required qualities, and the cement was good.

M.V.K.

Pyrenees cement plant solves power problem. RAFAEL DE RAFAEL. *Cemento*, **1**, 197–203 (1929); *Pit and Quarry*, **20** [4], 78 (1930).—The Compania General de Asfaltos y Portland "Asland" was formed in 1901. The output of all Spain that year was 1,450,000 T. compared with 420,000 T. in 1913, and Spain's proportion of the world output had risen from 1% in 1913 to 2% in 1927.

E.P.R.

Masonry cement of high plasticity introduced. ANON. *Pit and Quarry*, **20** [4], 27 (1930).—The Oregon Portland Cement Co. has introduced a new product called "Oregon Masonry Cement." The new material has a base of Portland cement to which is added ground limestone rock and aquagel, the latter producing greater plasticity in the mortar. The initial setting for the mortar is said to be 5 to 6 hrs.; final setting, $8^1/_2$ to $9^1/_2$ hrs.

E.P.R.

Behavior of cement aggregates and concrete at high temperatures. R. GRÜN AND H. BECKMANN. *Cement and Cement Mfg.*, **3**, 430 (1930).—A study of fire resistance of concrete. The report deals with (1) chemical reactions (*a*) elimination of water in relation to temperature and time of exposure, (*b*) elimination of CO_2; (2) physical reaction (*a*) change of volume, (*b*) change of strength. Summary: (1), Concrete stands up well even at high temperatures. Collapse occurs at 1150°C with a load of 2 kg. per sq. cm. (2) Cements containing pozzuolana show better general results than Portland cements. (3) Quartz aggregates, especially granite, give poor results; limestone is better up to 700°C and blast-furnace slag is better than natural aggregate. (4) Sudden cooling in water causes marked deterioration even at temperatures of 300°C.

W.L.

Cement past and present. D. B. BULLU. *Cement and Cement Mfg.*, **3**, 273 (1930).—A discussion of the changes which have occurred during the past fifty years in the mechanical processes of manufacture and in the physical properties of Portland cement.

W.L.

Hot cement. H. DAVEY. *Cement and Cement Mfg.*, **3**, 413 (1930).—The term "hot cement" is here referred to cement that is hot to the touch. The cement becomes hot through the frictional heat developed during grinding. A sample of cement was taken as it left the finish mill at 140°C. Test specimens were prepared from the cement when it was at 122°C, and at lower temperatures. When the cement was hot it required more water to give normal consistency. The hot cement set more quickly than cool cement. Sand mortar briquets prepared from the hot cement gave lower strength (16.5% lower at 28 days) than the cooled cement. The crushing strengths of concrete prepared from cement of various temperatures show no apparent effect of temperature of the cement on the strength. W.L.

BOOKS AND BULLETINS

Cement and Concrete. ANON. *Pit and Quarry*, **19** [3], 88 (1929).—A general reference book, 1929, of 64 pp. has been published by the Portland Cement Assn. It is a compendium of useful information drawn from authoritative sources on the cement industry and the manufacture of Portland cement. E.P.R.

Waterproof and wearproof for permanence. ANON. *Pit and Quarry*, **19** [3], 114 (1929).—The Advance Waterproof Cement Co. has issued an 8 p. pamphlet describing reground Portland cement and Hydro-Corundum Portland cement and their uses. E.P.R.

Mortar perfection. ANON. *Pit and Quarry*, **20** [5], 80 (1930).—The Carney Co. has issued a bulletin of 8 pp. and 6 illustrations describing the use of a cement made for brick and tile mortar and shows illustrations of some of the larger construction projects on which it has been used. E.P.R.

PATENT

Gypsum cement. OTTO F. HONUS. Ger. 477,212,; *Pit and Quarry*, **19** [3], 112 (1929).—Gypsum rich in Al_2O_3 is used instead of bauxite in the manufacture of fusible cements, SO_2 being obtained as a by-product. Thus, the gypsum may be heated with bituminous shale, clay, or bog iron ore, or a baryta cement may be obtained by heating the gypsum with residues from the manufacture of BaS, if necessary with addition of Al silicate and sand. E.P.R.

Enamels

Relationship of enamels and glasses. H. J. KARMAUS. *Emaillewaren-Ind.*, **7** [15], 116 (1930).—K. investigated the relationship between enamels, glasses, and glazes. He also compared the preparation and fusion in tanks and rotary kilns. The preparation of powder and wet enamels is given. A survey of the processes of sheet metal and cast-iron enameling is outlined. K. does not consider the ground frit used on cast iron as a homogeneous glaze but as a kind of ceramic paste, as the particles of the ground frit are cemented by only a small quantity of flux (borax). A discussion of the chemical structure of comparison objects follows, in which the different purposes of ordinary batches are indicated. M.V.K.

Relation of enamels to glass and to ceramic glazes. H. J. KARMAUS. *Glastech. Ber.*, **7** [10], 455–62 (1930); *Diamant*, **51** [34], 664–65 (1929).—The separate groups of silicate chemistry, the enamel and glass industry, produce vitreous glasses as a common material. As enamel is derived through the same historical development as glass and ceramic glazes the three industries have many kindred relations. Enamels which formerly were melted in small reverberatory smelting furnaces are now being melted in rotary oil-fired furnaces. The finished melt was granulated in water, and the granu-

lated material was either dried to a powder or ground wet to a paste with water, clay, and opacifying materials. The production of ceramic glazes is carried out in a similar manner. Generally they were melted in reverberatory furnaces and then ground wet with an addition of clay. To attain the adherence of the enamels on cast iron it is necessary to use a ground coat. The batches used for cast iron produce no true glasses but are similar to fritted porcelains. The sheet metal ground coat can be considered as a glass. The expansion coefficient is the most important constant of the physical properties. The remaining properties accord well with the conceptions and knowledge of glasses, so that the relationship in this respect is very close. Chemical composition experimental limiting values for the different branches of application have been set up in the glass industry, and the situation is similar in ceramic glazes. The composition of enamels permits so many variations that a precise specification of limiting values for enamels is not possible, so a table of enamels of the same fields of application is given as examples. For a special consideration of the kindred relat ons a chem cotechnical pedigree of glasses is shown. How far the similarity in regard to their synthesis goes is shown in a table in which the different columns are collated with every one of the representatives of these three industries. A numerical determination of the hydraulic stability is obtainable only with glasses. An experiment is described, according to which it is eventually possible to use a common method for the determination of stability for all three industries. If all claims are correct, it can be checked only through systematic investigation, but in any case, a working together of these three closely related industries is to be striven for more in a technical scientific respect.

E.J.V.

Systematic method for the investigation of sheet-iron enamels. A. I. ANDREWS. *Jour. Amer. Ceram. Soc.*, **13** [7], 489–97 (1930).—A study was made of the compositions of twenty-four sheet-iron ground coats and twenty-four sheet-iron cover enamels. The results were plotted on triaxial diagrams and interpreted. Some laboratory results are given and the reading of triaxial diagrams is explained.

Blistering phenomena in the enameling of cast iron. A. I. KRYNITSKY AND W. N. HARRISON. Bur. Stand., *Jour. Research*, **4** [6], 757–807 (1930); for abstract see *Ceram. Abs.*, **9** [2], 85 (1930). R.A.H.

Causes of blisters on enameled iron. ANON. *Iron Age*, **125** [20], 1451 (1930).—Recent investigations were made at the Bureau of Standards on three samples of cast iron intended for enameling which gave serious trouble in regular production. Under the microscope the following defects were noted: Sample 1 had a spongy texture in the iron immediately under the blister; a recognized mechanical cause of the defect. Sample 2 was a steel iron mixture melted in an electric furnace in such a way that the resulting casting contained only 1.2% Si and showed a eutectic structure with an excessive amount of very finely divided graphite. It was believed that this carbon was readily oxidizable during firing to a gas which caused defects in the coating and the trouble was corrected by reducing the amount of steel scrap and increasing the Si content. Sample 3 was normal chemically and sound when examined under the microscope but the blistering was found to be due to sandblasting and annealing before starting the operations. E.C.C.

Production of casts for enameling. H. ILLIES. *Emaillewaren-Ind.*, **7** [15], 115; [16], 124 (1930).—Casts for enameling are thin and do not require great solidity. The composition of the iron is important, the best being 3.5 to 3.7% of total carbon, 2.5 to 3.0% silicon, 0.3 to 0.5% manganese, 0.06 to 0.09% sulphur, and 1.4 to 1.8% phosphorus. This iron has a cubic expansion of 330 and is well adapted for different kinds of enamels. Green sand is used for the molds, with the following composition: silica 90%, alumina 10%, lime not more than 0.5%, low clay content. The coating

sand is composed of 9 parts sand from old forms, 5 parts fresh sand and 1 part coal dust. The cast must be taken out of the forms as soon as possible after pouring to avoid rusting, which prevents the adherence of the enamel. Use of acids is not recommended as porous iron absorbs them in great quantities and they cause the formation of bubbles in the enamel coating during firing. The ideal enamel, which must be thin has fine luster, good covering properties, and is difficult to obtain. *I.e.*, flux materials (borax, soda, potash) used to produce a good luster, lower the fusing point and the resistance to acids of enamels. Again, an enamel containing silica (50 to 60%) added to raise the fusing point and resistance to acids, is difficult to apply and lacks luster. There are three kinds of enamels: (1) opaque, a white porcelain-like enamel, (2) half-transparent, used as protection against rust in the interior of cast containers, and (3) transparent, containing lead oxide and having a low fusing temperature. The dry or powder process of enameling casts consists in heating the cast and sprinkling the powdered enamel on it. The cast is again refired till the enamel is fused. A majolica effect is obtained by heating to redness a cast which has a ground coat or is covered with white enamel, then powdering with the enamel. This enamel consists of 60 to 70% silica, 10% alumina, and 10 to 20% borax. In the wet process of enameling the cold cast is covered with a cold liquid enamel. Sometimes the cast is first covered with a thick layer of refractory enamel (80% silica), cooled, moistened with water, and sprinkled with enamel. After drying, it is fired. M.V.K.

New processes of enameling. WALTER OBST. *Emaillewaren-Ind.*, **7** [16], 121–22 (1930).—The unsuccessful attempts of investigators to obtain luminous enamel are discussed. W. describes new processes of removing enamel from metals. The object is immersed in fused salt mixtures preferably alkali nitrates and alkali nitrites. The iron is not affected as in the case of the treatment with 10% sulphuric acid and dilute soda solution. A process of removing enamels which works only under high pressure is by treating with a hot watery caustic soda solution which contains an oxidizing agent, as pyrolusite or saltpeter. Acetic acid has also a dissolving action on the enamel coat, a 20% solution having maximum effect. A description of the processes and investigations of D. Clawson and John F. Shephard is given. M.V.K.

Waste heat from enamel furnaces used for drying enamelware. R. A. BEVERLEY. *Ceram. Ind.*, **14** [6], 646–47 (1931).—B. gives reasons for past failures of recuperators, names the qualities necessary for a successful design, and describes, with line drawings to illustrate, a successful recuperator for application to enamel furnaces. See also *Ceram. Abs.*, **9** [4], 264 (1930). W.W.M.

Castings intended for enameling. A. MUELLER AND L. J. GOUTTIER. *Fonderie moderne*, **23**, 221–23 (1929).—The influence, from the enameling point of view, of different elements contained in metal for casting is taken up and the compositions of best castings for enameling are given. (*C.A.*)

Silicon alloys and steel melting. ANON. *Iron Age*, **125** [19], 1385–87 (1930). E.C.C.

BOOKS

Foundry Work. WILLIAM C. STIMPSON AND BURTON L. GRAY. Revised by John Grennan, Chicago. American Technical Society. 202 pp. Price $2.00. A practical handbook on standard foundry practice, including hand and machine molding with typical problems, casting operations, etc. (*C.A.*)

Enamels, Their Composition, and Properties. (Die Emaille, ihre Zusammensetzung und Eigenschaften.) LOUIS VIELHABER. 2nd ed. Emaillewaren Ind., Duisburg. Rm 2. Reviewed in *Sprechsaal*, **63** [18], 338 (1930).—This work of V. treats the most difficult part of enamel technique, the properties of enamels and ground-coatings: expansion, elasticity, tension, resistance to pressure and tensile strength, fusibility, re-

sistance to strokes and percussion, insensitiveness against change of temperatures, resistance to acids, appearance, and price of preparation. M.V.K.

Preparation of Enamel Batches. (Die Konstruktion der Emailleversätze.) LOUIS VIELHABER. Volume II. Adler, Meissen. Reviewed in *Sprechsaal*, **63** [18], 338 (1930).—The work is divided in four parts: (1) raw materials, (2) preparation of pastes, (3) composition of enamel batches, and (4) important tables for practice. Of special value are the chapters on the composition of the batches, where V. gives many examples which, however, are not intended for practice but are merely for illustration. M.V.K.

Knowledge of Enamel. (Emaille-Wissenschaft.) I. PH. EYER. Emailtechnisches Monatsbäter, Halberstadt, 1929. Rm 6. Reviewed in *Sprechsaal*, **63** [20], 376 (1930).—E. discusses in the first part of the book the production of stamped ware in enamel factories. The second part is devoted to the chemistry of enamels. M.V.K.

Enamel Manufacture. (Die Emailfabrikation.) LUDWIG STUCKERT. *Z. oesterr. chem. Ztg.*, **33** [8], 68 (1930); for abstract see *Ceram. Abs.*, **9** [4], 265 (1930). L.T.B.

PATENTS

Loading and unloading enameling furnaces. LAWRENCE J. STEVENSON. U. S. 1,761,996, June 3, 1930. In an apparatus for charging and unloading enameling furnaces the combination of a vertically movable track support and a longitudinally reciprocable fork member carried thereby, the fork member comprising aligned beams parallel with the track and having flanged wheels contacting with the latter, guide members projecting upwardly from the track and having a rolling contact with the upper periphery of the wheels, rollers mounted on the track and contacting with the fork member, the rollers coöperating with the guide members for maintaining the fork in a horizontal plane during the longitudinal reciprocation of the latter, a plurality of spaced loop members having their ends loosely resting on the aligned beams of the fork, and a plurality of spaced bars disposed in parallel relation to the beams of the fork and loosely resting on the loop members, the bars having spaced upwardly projecting article-supporting points adapted to receive articles to be deposited in and removed from the furnace, whereby provision for handling articles of varying sizes and shapes is assured.

Grate or burning bar for enameling furnaces. KARL TÜRK. U. S. 1,762,001, June 3, 1930. In a grate bar for enameling furnaces the combination of a pointed cap having a recess in its bottom, means on the grate bar engaging the socket and interlocking means on the cap for preventing upward movement of the cap away from the grate bar.

Coating articles with enamel. NATHANIEL B. ORNITZ. U. S. 1,762,239, June 10, 1930. The method of enameling long articles which consists in coating the articles with fluid enamel and then moving the articles endwise slowly into and out of a furnace while supporting the article outside the furnace only.

Tin, titanium, and zirconium oxides. DEUTSCHE GOLD-UND SILBER-SCHEIDEANSTALT VORM ROESSLER AND L. WEISS. Brit. 327,142, May 21, 1930. In a process for obtaining highly dispersive oxides of tin, titanium, or zirconium, suitable for use as pigments, turbidity agents for vitreous enamels, etc., soluble compounds of these metals are allowed to react in their normal conditions or in the presence of limited quantities of solvents with substances capable of converting them into oxides, *e.g.*, alkaline lyes, steam, ammonia, etc., and the oxides or hydroxides produced are heated in the case of pigments from 500 to 800°C, and turbidity agents from 900 to 1500°C, to convert them into a voluminous form. The initial reaction can take place either in the liquid phase or between the vapors of the reactants. If the reaction in the vaporous phase takes

place above 600°C the subsequent heating may be omitted. In examples, (1) titanium tetrachloride in the form of vapor is allowed to react with superheated steam at 500°C and the oxide formed is washed, dried, and heated from 600 to 800°C to produce a pigment; (2) zirconium oxychloride or a concentrated solution thereof is stirred with concentrated ammonia solution, the pasty mass diluted with water, and the precipitate washed, dried, and heated from 1200 to 1400°C and a turbidity agent obtained; (3) the vapor of stannic chloride is treated with superheated steam at 300°C, and the oxide product is washed, dried, and heated to a little above 900°C to produce a turbidity agent. See also Brit. 296,730, *Ceram. Abs.*, **8** [2], 151 (1929); Brit. 203,352 and 206,284.

Enamels and glazes. DEUTSCHE GASGLÜHLICHT-AUER-G. M. B. H. Ger. 488,507, Jan. 7, 1925. A turbidity agent for enamels and glazes is prepared by heating basic Zr salts of organic acids to glowing, till the whole of the acid is removed, leaving pure ZrO_2. (*C.A.*)

Enamel. A.-G. DER HOLLER'SCHEN CARLSHÜTTE BEI RENDSBURG. Ger. 488,840, Sept. 13, 1928. Marble-like, mottled or streaked enamel is produced on cast or sheet Fe by applying a white or colored sub-layer and a layer of vitrifiable pigments in the pattern desired. These layers are pressed on by the aid of an elastic, transparent, glossy, nonporous covering of oiled paper, cellulose, or parchment and subjected to a vitrifying temperature. (*C.A.*)

Enamel and glass. IGNAZ KREIDL. Ger. 492,708, Jan. 16, 1927. A white clouding agent for enamel, glass, etc., comprises synthetic compound silicates of Al and alkali or alkaline earth metals in which the proportion of Al_2O_3 to SiO_2 is roughly the same as in $Al_2(SiO_2)_3$. See also *Ceram. Abs.*, **8** [2], 100 (1929). (*C.A.*)

Glass

Behavior of glasses in their softening interval. G. TAMMANN. *Glastech. Ber.*, **7** [10], 445–54 (1930); *Diamant*, **51** [34], 664 (1929).—Brittleness is characteristic of glasses. The temperature at which an undercooled liquid is brittle can be determined to ±1°, inasmuch as it can be ascertained at which temperatures large flaws no longer appear and at which they still form, or in that cracking can be produced at different temperatures. As long as the body is brittle jagged cracks appear, but if the brittleness decreases the edges of the cracks are smooth. At the temperature of brittleness the rules of the physical properties dependent on temperature, the volume, heat content, refractive index, and dielectric constants, are changed. The density of glasses increases with the pressure under which they congeal. The heat expansion of glasses decreases with increasing pressure and above 1000 atmospheres is negative. This applies up to the temperature of brittleness; from this temperature upward the heat expansion is also positive at high pressures. Temperature conductivity has a pronounced fixed minimum above the temperature of disappearance of brittleness. These new ideas were examined from the standpoint of the molecular theory by T. E.J.V.

Principles of annealing window glass. F. TAFFIN. *Rev. belge ind. verrières*, **1**, 50–51 (1930).—According to T. the general mathematical law for the annealing of glass may be stated as follows: $\log (1/\delta - 1/\Delta^\circ)/(1/\delta - 1/\Delta) = t/T$ [see *Compt. rend.*, **173**, 1347 (1921); **174**, 36 and 159 (1922)], where Δ and Δ° measure respectively the birefringence of the glass at the times t and t_0; δ is an exponential and T a linear function of the temperature. This is more complex than the formula of Adams and Williamson (*Jour. Franklin Inst.*, Nov. and Dec., 1920). The proposed law of annealing implies the following conditions: (1) There exists a certain temperature (θ°) for which the speed of disappearance of internal stress is infinite. This renounces the theory

that the passage from the solid state to the liquid state is continuous. (2) At any temperature, solid glass is able to undergo the same deformations as any solid. These deformations are (*a*) elastic, in which the body takes its original form as soon as the stress is released, (*b*) subpermanent, in which the body takes its original form only after a certain time has elapsed; *e.g.*, zero displacement of a thermometer and the return to zero, and (*c*) permanent or viscous deformations, which cause the body to keep the shape it had at the instant the stress was removed. The annealing of glass is an example of the third type for it is a viscous deformation under the action of internal stresses. During annealing the glass is deformed by the internal stresses until these stresses become equal to the elastic limit. Then the glass no longer deforms. The elastic limit of glass decreases when the temperature θ increases according to the equation $\delta = C_1 e^{C_2(\theta^\circ - \theta)}$, where C_1 and C_2 are constants, e is the base of the natural system of logarithms, δ is the elastic limit. At the temperature of instantaneous annealing $\delta = C_1$ and T. found a value of 1 kg. per cm.^{2} for the glass he studied. According to this, perfect annealing is impossible because a glass will always be under internal stress equal to the value of the elastic limit at the temperature of annealing, but the residual stress is almost negligible. The time of relaxation, T, is fixed at any given temperature but becomes zero at the temperature of instantaneous annealing. The variation of T with temperature is as follows: $T = k(\theta^\circ - \theta)$, where k is a constant. The speed of disappearance of internal stress Δ may be shown by the equation $d\Delta/dt = \Delta(\Delta - \delta)/T\delta$. This is interpreted as follows: (*a*) The stresses disappear instantaneously at the temperature of rapid annealing ($T = 0$). (*b*) The stresses disappear more rapidly when they are high and when they are much different than the elastic limit. (*c*) The annealing stops when the stresses become equal to the elastic limit ($\Delta = \delta$). By slowly heating a piece of strained window glass between crossed nicols, the temperature of rapid annealing was found to be 550°C. The temperature at which a glass can no longer be hardened by strain because the elastic limit exceeds the stress required to cause rupture is called the tempering temperature of the glass and is about 100°C lower than the temperature of rapid annealing. A.J.M.

Devitrification. I. I. KITAIGORODSKY. *Rev. belge ind. verrières*, **1**, 55–56 (1930).—For glasses containing 1 molecule of alkalis the dangerous temperature is about 950°C. With more than 1 molecule of alkalis the danger temperatures are 900 to 920°C. The conclusions of K. are (1) the presence of alumina usually reduces the crystallizing power, but not always. (2) Other things being equal, an increase in alkali content reduces crystallization. (3) Increased complexity of chemical composition reduces the tendency to crystallize. (4) The CaO content should not exceed 10%. (5) Glasses containing 11% or more of lime and 14% of alkalis have large crystallizing power. (6) Glasses that do not contain alumina and have equal percentages of lime, crystallize more rapidly as the alkali content is decreased. (7) When magnesia (in the form of magnesite) is substituted for lime in a normal glass, the crystallization tendency is increased. This last conclusion is opposed to the generally accepted theory. A.J.M.

Some properties of glasses containing zinc oxide. S. ENGLISH, W. E. S. TURNER, AND F. WINKS. *Jour. Soc. Glass Tech.*, **12** [48], 287–95 (1928).—The glasses studied were of the soda-zinc oxide-silica series and belonged to the type $6SiO_2(2-x)Na_2O, xRO$ on which the authors have based many similar glass studies. Only in a general way are the effects of zinc oxide on glasses known. Glasses containing 1.29% zinc oxide were easily melted and easily worked, but with an increase of zinc oxide the working range shortened, the viscosity increased, and there was evidence of cords. When the zinc oxide content reached 15.22% the glass was cordy and very difficult to work. Replacement of sodium oxide by zinc oxide in the series brought a steady rise of density from about 2.45 to 2.54. The constant for calculation of density has been evaluated

as 7.5, the older value being 5.9. The annealing temperature by two methods was scarcely affected by substitution of zinc oxide for sodium oxide. A straight line relationship exists between composition and thermal expansion. Three quite definite change points occur in the expansion rate over a range of temperature from O to A_t for glasses containing 4.55% ZnO. (A_t is the lower temperature end of the annealing range.) Only two were found for glasses with 6 to 11% ZnO. Complete data are given in an appendix until some clear meaning is obtained for these changes in the lower temperature range. The index of refraction gradually increases for increasing ZnO content. The average value of the total dispersion is 0.00873 and that of v is 57.8. These values almost coincide with those for the effect of lime in glasses of similar composition. G.R.S.

Determination of iron content in red lead for crystal glass. FRANZ HUNDESHAGEN. *Glas-Ind.*, **37** [13], 194–95; [14], 203–204 (1929).—Some of the methods of analysis usually used for determining the iron content in red lead are discussed and their good and bad features pointed out. E.J.V.

Qualitative and quantitative determination of the gas contents of bubbles in glass. J. ENSS. *Glastech. Ber.*, **7** [9], 384–86 (1929).—The microphysical gas analysis method of August Krogh, while devised primarily for biological purposes, is applicable in the field of glass technology for the determination of gases in bubbles in fined glass. The principle and actual use of the method is explained in detail. It is possible by the use of appropriate media, to analyze for CO_2, CO, SO_2, O_2, H_2, N_2, and mixed gases. The method has an accuracy great enough for its practical application. E.J.V.

Purification of glass. G. GEHLHOFF, H. KALSING, AND M. THOMAS. *Glastech. Ber.*, **8** [1], 1–24 (1930); see also *Ceram. Abs.*, **9** [3], 172 (1930). E.J.V.

Effects of additions of CaO and MgO on enamel glasses. C. W. PARMELEE AND D. T. SHAW. *Jour. Amer. Ceram. Soc.*, **13** [7], 498–508 (1930); for abstract see *Ceram. Abs.*, **9** [3], 167 (1930).

Effects of additions of zinc oxide and cadmium oxide on simple glasses. C. W. PARMELEE AND R. G. EHMAN. *Jour. Amer. Ceram. Soc.*, **13** [7], 475–88 (1930); for abstract see *Ceram. Abs.*, **9** [3], 167 (1930).

Rate of crystal growth in technical soda-lime-silica glasses. II. ADOLF DIETZEL. *Glass Ind.*, **11** [6], 132–37 (1930).—Tables and figures are presented in this instalment. See also *Ceram. Abs.*, **9** [7], 516 (1930). E.J.V.

Fluor opal and the theory of opaque glasses. E. ZSCHIMMER. *Sprechsaal*, **63** [19], 347–49; [20], 364–66 (1930).—Z. reviews the existing literature on fluor opal glasses. He discusses the theories of opaque glasses, and describes tests made by different investigators. M.V.K.

Radioactive methods for the testing of the properties of glasses. OTTO HAHN AND HELMUT MÜLLER. *Glastech. Ber.*, **7** [9], 380–83 (1929).—Some new methods of using radioactive emanations in the testing of glass properties are discussed. These methods cannot replace the methods used up to now but are of use in special testing. E.J.V.

Measuring expansion on single glasses with the aid of a self-registering apparatus. WILLI M. COHN. *Sprechsaal*, **63** [16], 287–89; [17], 304–306 (1930); for abstract see *Ceram. Abs.*, **9** [3], 169 (1930). M.V.K.

Automatic regulator and its application in the glass industry. OSCAR KNAPP. *Glas-Ind.*, **37** [11], 167–70; [12], 179–80 (1929).—A general discussion of various types of automatic regulators which are applicable in various processes in the glass industry is presented. Particular makes of regulators are discussed in detail and their various good and bad features are enumerated. Illustrated. E.J.V.

New chain device gives added protection in replacing furnace pots and tank blocks. ANON. *Amer. Glass Rev.*, **49** [33], 15–16 (1930).—The E. J. Codd Co., Baltimore,

Md., is manufacturing a new idea in chain shadow pans for changing pots and repairing tanks in the glass factories. The primary purpose of the Wiegand chain shadow pan is a shield or screen permitting a clear, unhampered view of the heated interior of pot furnaces and tanks. The chain shadow pan is a multitude of freely hanging individual strands of a specially constructed steel chain suspended from a bar forming a continuous sheet or curtain of chain. The heat coming from an uncovered glass furnace measures well over 600°, yet it is possible to hold your hand within an inch of a Wiegand screen hung before a glaring furnace without feeling any discomfort. The chain screens may also be used at the dog houses or loading doors of glass furnaces, where they do not interfere with the passage of the materials composing the batch. The chain screens may also be employed on steam boiler furnaces, where they will protect the tubes from chill and the stokers from out-pouring heat and glare when cleaning or coaling the fires. E.P.R.

Modernization of the glass-melting tank. ANON. *Nat. Glass Budget*, **46** [5], 3 (1930).—The demand is for a wide range of colors. These new conditions require a change in the melting tanks to provide uninterrupted producing conditions and increased flexibility as to colors. Tanks for the melting of glass will gradually decrease in hearth depth as the quality of refractories is developed to permit the continuous melting and flow of glass on a refractory hearth. The Amco superheater tank with air superheater is a departure from the regenerative or ordinary recuperative type. It has uniform air temperature and constant flame temperature in a fixed path designed to sweep the entire melting hearth. The tank is usually built with two compartments and is as successful as the single compartment tank. Color changes may be made frequently to meet existing demands. E.P.R.

Drawing of grooves in glass. ANON. *Glas-Ind.*, **37** [12], 184 (1929).—The method of drawing grooves or rabbets in glass mechanically is discussed. E.J.V.

Drilling glass. HENRY C. LANGE. *Abrasive Ind.*, **11** [6], 36–37 (1930).—For holes up to $^3/_8$ in. in diameter use a solid drill made from a triangular file with the point ground to a 3-sided taper. For holes larger than $^3/_8$ in. use a tube drill. Silicon carbide grain, 70 grit, mixed with water to a thin paste should be put around the drill inside the dam. Work the drill up and down intermittently. With solid drills use a speed of 125 r.p.m.; with tube drills use 975 r.p.m. to about 275 r.p.m. depending on size of drill. E.P.R.

Theory of glass coloration. I. F. PONOMAREV. *Zhur. Prikladnoi Fiz.*, **4** [3], 31–34 (1927).—The substances producing color within glass are divided into two groups: (1) oxides or salt-like compounds forming molecular solutions with glass, and (2) elements, compounds, or oxides distributed within the glass in the form of a dispersed phase. In the latter case the color is a function of the degree of the dispersion of the substance. Only a very few substances belong to the first group. They are oxides of elements belonging to the fourth row of the 6, 7, 8 groups in the periodic table. (*C.A.*)

Appropriate and correct decolorization of glasses. ANON. *Glas-Ind.*, **37** [15], 216–17 (1929).—The various chemicals present in glass and their coloring action are discussed. Materials which can be added to offset these colors or decolorize the glass are enumerated. In many cases a colorant is added which serves to neutralize the color of the glass and thus decolorize it. A typical decolorizing mix is given. E.J.V.

How earths affect glass. ANON. *Sci. Amer.; Nat. Glass Budget*, **46** [6], 27 (1930).—It has been found that certain elements, particularly the rare earths, impart a delicate tint to glass which filters out those rays of the sun which tend to "crack" gasoline. A trace of neodymium in the glass of spectacles should partially correct color blindness. Weidert, of the Kaiser Wilhelm Institute for Silicate Research of Berlin, and the director of the technical optics laboratory of the Berlin Technical High

School, recently discussed the use of the rare earth elements as components of glass. He pointed out that the one gram of neodymium or praseodymium cost 20 marks before the war, but is now much cheaper. Didymium glass was used during the war for secret optical telegraphy. Glass containing cerium was used in spectacles to cut out ultra-violet light, and zirconium was used in the production of cloudy opal glass. Neodymium glass is especially suitable, by insertion before mercury vapor lamps, for the production of monochromatic light. Neodymium makes red or green appear sharper; it may, therefore, be used to correct incomplete color-blindness. Recently, neodymium and praseodymium have been applied extensively in the manufacture of art glasses. In these, the color depends on the thickness of the glass, so that parts of varying thickness show a changing play of colors; the glass is, therefore, used in the production of artificial gems. The color also depends on that of the incident light; *e.g.*, praseodymium glass is green in daylight and colorless in candlelight. E.P.R.

Sources of visible and infra-red radiation for deep therapy. M. LUCKIESH. *Jour. Frank. Inst.*, **207** [1], 79–94 (1929).—Progress in the scientific development of radiation therapy has been seriously retarded by insufficient consideration and understanding of physical science on the part of investigators and practitioners. This paper deals mainly with infra-red radiation which is applied to induce heat into physiological tissues under the term "deep therapy," which term in this paper applies only to the use of visible and infra-red radiations for heating at a depth. The transmission factors of radiant energy of various wave-lengths throughout the visible and near infra-red region are presented for water of four different thicknesses. In the case of infra-red radiation the transmission of energy from incandescent solids at various temperatures is discussed. Many useful curves are given. Measurements show that a tungsten filament at 3500°K is the best source of reaction, and the use of carbon filament lamps is not advantageous for mechanical reasons. Any modification by means of colored bulbs decreases their efficacy by reducing the amount of radiant energy available. The emission of infra-red energy from nonluminous (black body) objects is also considered. Curves are given for the infra-red transmission via glass. Most glasses are transparent to λ 28,000, the transparency decreases beyond λ 30,000, but quite efficient transmission is obtained as far as λ 40,000. M.A.B.

Making glass from nepheline. F. W. PRESTON. *Glass Ind.*, **11** [6], 131 (1930).—It is reported that a glass factory in Leningrad, Russia, has been making glass from nepheline, an aluminium silicate, which it is claimed does not require mixture with soda and sulphate. Nepheline is one of the accessory minerals of sundry igneous rocks. It is widely distributed, but nearly always present in only very small amounts. Occasionally it occurs massive, in large lumps and in quantity as feldspar does in Canada. E.J.V.

Vanadium and some of its uses. JEROME ALEXANDER. *Glass Ind.*, **11** [6], 131 (1930); for abstract see *Ceram. Abs.*, **8** [12], 873 (1929). E.J.V.

Natural glass. F. W. PRESTON. *Glass Ind.*, **11** [6], 139 (1930).—Many volcanic lavas are partly or wholly glassy. Obsidians and pitchstones are commonly described, and correctly, as natural glass. They are, of course, generally deeply colored, but that is a property shared by many manufactured glasses. Further, many of the other volcanic rocks, such as basalt, occur quite frequently in the form of colored glass with an admixture of crystals. Like many glasses from an industrial tank, these natural glasses often show "flow-lines" or striae. There is no doubt that the amount of natural glass in the world vastly exceeds the total of the manufactured product. Illustrated. E.J.V.

Characteristics of glass developed in manufacture. ROY E. SWAIN. *Glass Ind.*, **11** [6], 125–30 (1930).—It is fairly easy to distinguish between plate glass and blown or drawn glass, for the polished plate glass presents a perfectly plain surface while drawn

or blown glass shows slight surface undulations. The trained window glass man determines the method of manufacture by the slight bow of the sheet, the shape of the bubbles or seeds, drawing-block marks, slight surface sheen, and other characteristics. The paste mold tumbler is very light, especially at the edge, has a high surface polish, and usually gives out a clear musical ring when tapped. Closer examination discloses a number of fine lines running around the article and concentric circles showing on the bottom. The "hot mold" thin blown tumbler has about the middle section an "optic band" caused by unequal distribution. Pressed ware may be distinguished by the mechanical execution, the surface pattern produced by the grain of the mold material the seams indicating the joints of the mold and the more or less prevalent shear mark Ware made by straight pressing is heavy, vertical seams run from top to bottom an while usually finished and ornamented by means of panels, etc., the usual marks o pressed glass may be detected by close examination. The various methods of making flat ware and their distinguishing marks are discussed. Among the decorative and finishing processes are the "optic," the result of unequal distribution of glass in adjacent sections of the article; water crackling, by breaking up the outer surface of the glass; annealing, etc. Crackled glass, fluted optic and heavy walled articles do not finish well by glazing so are generally finished by stone polishing. This finish presents a plain surface slightly beveled at the edge and lacks the gloss of fire finished ware. Glass is so sensitive that it makes a record of practically every operation used in its manufacture. E.J.V.

Using ultra-violet glass. ANON. *Nat. Glass Budget*, **46** [3], 10 (1930).—Sunshine, brought indoors by means of special window glass, has demonstrated that it has an actual cash value. The Pilot Life Insurance Co. of Greensboro, N. C., and Ferranti Ltd., of England and Canada, have completed tests showing that they have saved a substantial sum through decreased absences since giving their employees ultra-violet radiation. E.P.R.

Transmission changes in ultra-violet glasses during high temperature exposure to light. C. C. NITCHIE AND F. C. SCHMITZ. *Science*, **71** [1849], 590 (1930).—Recent experiments with several well-known brands of glasses transparent to ultra-violet radiation have shown that if the specimens of glass are attached directly in contact with the hot tube of the mercury arc lamp and thus kept at a high temperature (450°C) during the ultra-violet exposure, there will be no decrease in short wave transmission, but instead, a marked increase. Not all the glasses behaved in the way described. One in particular showed only a barely detectable decrease in transmission on low-temperature exposure, and no change whatever after exposure in contact with the lamp tube. G.R.S.

Characteristics of light-diffusing glasses. L. BLOCH. *Glastech. Ber.*, **7** [9], 374–80 (1929).—The various properties of light-diffusing materials are listed and discussed. Methods of measuring these various properties are given. E.J.V.

Retardation phenomena in technical glasses. HANS JEBSEN-MARWEDEL. *Glastech. Ber.*, **7** [9], 383–84 (1929).—Some peculiar phenomena observed in glasses are discussed from a physico-chemical viewpoint. E.J.V.

Absorption spectra of iron carbonyl. I. DRECHSLER. *Arhiv za Hemiju i Farmaciju*, **2** [4], 175–97 (1928).—With the aid of a König-Martens-Grünbaum spectrophotometer, the absorption of light by $Fe(CO)_5$ in different solutions was measured for the visible part of the spectrum. For different thicknesses of strata and varying concentrations from 99 to 0.5%, a perfect accord with the law of Beer was found. The absorption of light by $Fe(CO)_5$ is independent of the solvent; the rule of Kundt could not therefore be confirmed. The speed of the photo reaction, on the other hand, is dependent to the highest degree on the nature of the medium. E.J.V.

Windows of double glass. ANON. *Rev. belge ind. verrières*, **1**, 54–55 (1930).—Experiments have shown that 2 sheets of glass 3 mm. thick separated by an air space of 1 cm. give only 30% less thermal insulation than 2 walls of concrete 5 cm. thick with a space of 5 cm. between them. A.J.M.

Making health-giving glass. ANON. *Sci. Amer.; Nat. Glass Budget*, **46** [6], 24 (1930).—The beneficial effects of the sun's rays have been known for centuries. The importance of ultra-violet rays of the sunlight to health and the fact that ordinary window glass cuts out nearly all of these beneficial rays has been recognized. Elihu Thomson, director of the General Electric Co.'s research laboratory at Lynn, Mass., took up the work of developing a material which would transmit the health rays, to replace window glass. Fused quartz was known as the best medium for the purpose. Many methods were investigated and special furnaces were developed before the engineers finally succeeded in making quartz in sheet form, and at a reasonable cost. The first method developed to produce a high-quality quartz glass consisted in fusing in a vacuum, specially selected and treated quartz crystals in a square fabricated graphite box, and pressing the fused mass of quartz at 1000 lbs. per sq. in. while in the molten state. This method of manufacture was considered too expensive for common use. In the present process, quartz crystal, crushed to $^1/_4$-in. mesh, is fused in a vacuum on flat graphite disks between thin graphite slabs in the form of a $7^1/_2$-in. square. A number of these trays are stacked in a form and placed in a high-temperature furnace. When the quartz is fused, nitrogen gas is admitted to the furnace at a pressure of 150 lbs. per sq. in. to compress the bubbles. The resulting quartz plates, upon cooling, require only squaring of the edges by grinding. The plates themselves are $7^1/_2$ in. square by $^1/_4$ in. thick. This new method does away with cutting, grinding, and polishing each pane, and the trays can be used a number of times. E.P.R.

Lighting and lighting fixtures. JOHN F. HARBESON. *Pencil Points*, **11** [6], 427–34 (1930).—For interiors, science has experimented with the relative values of reflected light or direct light, with the effects if transparent and translucent media, plain, sanded, etched, ribbed, and molded glass with different types of reflectors. Interesting effects have been obtained by so placing plates of glass that light shines through edges rather than sides. Lighting forms the entire decoration of the ballroom of the St. George Hotel, Brooklyn. Painted a flat white, a push button controls subtle variations of colored lights in patterns changing or motionless at the command of the remote control room. E.B.H.

Artificial illumination from walls of glass predicted. FOSTER GUNNISON. *Amer. Glass Rev.*, **49** [32], 20 (1930).—Artificial illumination from glass walls, constituting an innovation in lighting systems, was predicted recently by G. of Cox, Nostrand & Gunnison at the Architectural Lighting Conference in New York. Walls will be two layers of glass and in between them will be pumped a sort of gas and the whole wall will light. E.P.R.

"Light cubes" latest in decorative illumination. ANON. *Popular Sci.*, **116** [6], 34 (1930).—Cubes of heavy translucent glass, that can be built into various attractive designs, are the latest novelty in lighting. Lamps within the cubes throw a highly diffused illumination with no shadows at the corners. Bulbs of different colors can be put in them and an unusual effect is thus secured. The cubes range in size from four to twelve inches. Illustrated. E.J.V.

Glass walls. ROBERT E. MARTIN. *Popular Sci.*, **116** [6], 39 (1930).—Only within the last few months have architects realized that glass is a building material. A huge public building in Magdeburg, Germany, has five-story high walls of glass alternating with its sections of brick front. A department store has been built almost entirely of glass in Geisenkirchen, Germany. Brick of glass, manufactured in Holland and in

Germany, are now being imported for use in America. They have been used in part of the walls, on the upper stories, of the Barbizon Plaza, in New York. How practical it is to live in a glass house is shown by these walls. There is no lack of privacy. A ribbed design on the surface of the bricks lets light through but makes it impossible to see through them. Thus the first requirement of walls of glass is met. The glass brick are a little larger than clay brick, but are laid with mortar in exactly the same way. Interlocking ribs on their surface fit closely together, but allow one brick, if it ever breaks, to be slid out and replaced with another. Inside, the brick are hollow. This dead-air space is said to make them heat-insulating and soundproof. Illustrated. E.J.V.

Pickwick busses to be equipped with shatterproof glass. ANON. *Amer. Glass Rev.*, 49 [35], 28 (1930).—In the May issue of *Bus Transportation* appears an advertisement announcing that Johnston Shatterproof Glass has been adopted as standard equipment for all Pickwick Duplex observation coaches. E.P.R.

Huge telescope mirror made in great heat. ELIHU THOMSON. *Popular Sci.*, **117** [1], 47 (1930); *Amer. Glass Rev.*, **49** [25], 36 (1930); for abstract see *Ceram. Abs.*, 9 [5], 342 (1930). E.J.V.

New vogue in decorated glass sold by Indianapolis Glass Co. ANON. *Nat. Glass Budget*, **46** [6], 27 (1930).—The decorative qualities of sheet glass are greatly enhanced both for inside and outside purposes by the Ribbon-Miter cut designs that are now available. The Indianapolis Glass Co. is selling sheets of plate glass up to 120 in. in length upon which distinctive, beautiful, and practical designs are miter cut. This decoration improves the interior appearance of buildings as well as the outside when used in doors. The Ribbon-Miter method of cutting permits the execution of individual ideas; squares, rectangles, diamonds as well as many modernistic and novel designs can be produced. Any width line or combination of lines of various widths can be cut perfectly true in any length up to 120 in. E.P.R.

First glass mirrors. ANON. *Nat. Glass Budget*, **46** [2], 23 (1930).—The first reliable mention of glass mirrors covered with tin or lead occurs in the 13th Century in a treatise on optics by Peccan, an English Franciscan monk. He speaks of iron, steel, polished marble, and glass mirrors, and says that the last named were "covered on the back with lead, and that no image was reflected when the lead was scraped off." Bellovacensis, about the same period, also says that "the lead was poured over the glass plate while hot." E.P.R.

Does house fly dislike yellow glass? ANON. *Nat. Glass Budget*, **45** [51], 4 (1930).—Everything being equal the house fly prefers white to colored light, red and yellow being the best deterrents, according to *Nature*. Loss of illumination with red glass being too great, yellow is the better. Therefore, it is a valuable suggestion for food containers. Yellow glass is not suggested for buildings, as it is hard on the eyes and possibly on the general health. E.P.R.

BOOKS

Volumetric glassware. VERNEY STOTT. H. F. and G. WITTERBY, London. Reviewed in *Sprechsaal*, **63** [20], 376 (1930).—S. discusses the bases of calibrating, measuring bottles and cylinders, pipettes, burettes, the technique of marking and graduating and the action of the error apparatus on the results of the volumetric analysis. Illustrations, diagrams, and tables facilitate calculation and control of the measuring vessels. M.V.K.

Glassblowing in Scientific and Industrial Laboratories. (Le soufflage du verre dans les laboratoires scientifiques et industriels.) HENRI VIGREUX. Price, 35 F. Reviewed in *Rev. belge ind. verrières*, **1**, 67 (1930); for abstract see *Ceram. Abs.*, **9** [7], 521 (1930). A.J.M.

PATENTS

Frosting glass articles. ROWLAND D. SMITH. U. S. 17,682, May 27, 1930 (reissue). The method of preparing a frosting solution which consists in fusing a salt of an alkali metal of the first periodic group having an atomic weight between 22 and 40, grinding the fused material to the desired degree of fineness and then mixing it with proper batch materials to form a frosting solution.

Feeding molten glass. KARL E. PEILER. U. S. 1,760,254, May 27, 1930. (1) Apparatus for feeding molten glass, comprising a forehearth projecting from a tank and having a discharge outlet, a chute to receive glass from the outlet and direct it to a waste receptacle, means for supporting the chute for swinging movement longitudinally of the forehearth toward the front thereof into glass-receiving position and toward the rear thereof out of glass-receiving position, and a latch for retaining the chute in either of its positions. (2) Apparatus for feeding molten glass, comprising a forehearth having a submerged discharge outlet, an orifice ring forming a continuation of the outlet, a carrier for the ring pivotally mounted on the forehearth, a removable lever, a fulcrum for the lever carried by the forehearth, the carrier having a portion adapted to be engaged by the lever whereby the carrier and ring may be moved by the lever to and from their position below the outlet. (3) Apparatus for feeding molten glass, comprising a forehearth having an outlet, a feeding implement, an arm carrying the implement in substantially vertical alignment with the outlet, and means to adjust the arm horizontally both rectilinearly and angularly, the arm being mounted on a pivot about which the arm may be swung out of and into operative position. (4) Apparatus for feeding molten glass, comprising an implement movable to regulate the feed of the glass, a cam, connections between the cam and the implement, and means operable at will without direct manual actuation of the connections to move the connections out of and again into operative relation with the cam.

Cooling mechanism for glass-feeder shear blades. KARL E. PEILER. U. S. 1,760,255, May 27, 1930. Spray mechanism for coöperative shear blades of glass-feeding apparatus comprising a pair of spray heads adapted to discharge spray onto the shear blades when the shear blades are in their retracted positions, an atomizer, and a pair of spray conducting conduits connecting the atomizer and the discharge heads, the conduits being substantially equal in length and having substantially similar spray-conducting passages.

Melting glass, etc. WILLIAM A. MORTON. U. S. 1,760,371, May 27, 1930. (1) In apparatus for melting glass, the combination of a plurality of chambers which are atmospherically isolated, one of the chambers being a reducing chamber into which the materials are introduced and another of the chambers being an ebullition chamber, the chambers having a submerged connection between them, a circular weir in the ebullition chamber, the weir being surrounded by the molten glass in the ebullition chamber, a vertical passage into which the glass overflows and travels therethrough in the form of an extended sheet, a working chamber into which the glass travels from the passage, means for applying supermelting temperatures to the glass in the passage, and means for heating the ebullition chamber and the working chamber by waste heat from the passage. (2) In apparatus for melting glass, the combination of a passage through which the glass travels and wherein it is subject to the highest furnace temperatures, a working chamber into which the glass is delivered from the passage, a feeder boot to which the glass is supplied from the working chamber, a recuperator, and selective means for leading the heat currents from the passage into the working chamber and feeder boot on its way to the recuperator.

Preventing weathering of glass. ROBERT C. MATLOCK, JR. U. S. 1,760,427, May 27, 1930. The method of frosting glass articles which comprises subjecting the article

to the action of a highly concentrated fluoride etching solution for a limited interval of time, followed by a second etching action by a lesser strength fluoride solution for another interval of time and thereafter subjecting the etched glass surface to the action of a chemical solvent inert with respect to the glass but substantially capable of removing from the etched surface of the double alkali and alkaline earth metal silicofluorides formed by the etching reactions thereon.

Shear mechanism for glass feeders. KARL E. PEILER. U. S. 1,760,435, May 27, 1930. (1) Apparatus for separating molten glass into mold charges, comprising a movable glass-severing blade adjustable to different angular positions, and a guide for the mold charges movable with the blade and having a fixed angular position. (2) Glass-severing mechanism comprising a pair of pivotally mounted arms carrying shear blade gears connecting the arms to swing them toward and from each other, and means for adjusting the angular relation between the gears and their respective arms. (3) Apparatus for separating molten glass into mold charges, comprising a shear blade, means for producing a continuous discharge of air toward the blade, and means for periodically supplying oil to the air discharge so as to produce a periodic oil spray on the knife. (4) Glass-severing mechanism including a movable arm carrying a shear blade, an operating mechanism for the arm including a cam lever and a cam for actuating the cam lever, a latch carried by the cam lever, and means coöperable with the latch when the lever has been swung clear of the cam to prevent return movement of the cam lever toward the cam, whereby the shear blade will be maintained inoperative. (5) A pre-setting device for a pair of carrier-supported shear blades, one of the shear blades being angularly adjustable relatively to its carrier, comprising a block, a slide movably mounted on the block, means for securing one of the carriers to the block so that the shear blade on the carrier is turned toward the slide, means for securing the second carrier to the slide so that the blade of the second carrier overlaps the blade of the first carrier, and means for adjusting the slide relatively to the block to cause the overlapping portions of the blades to contact flatwise with each other.

Drawing sheet glass. VICTOR E. HOFMANN. U. S. 1,760,499, May 27, 1930. Apparatus for drawing sheet glass comprising an inclined drawing trough, means to flow molten glass into the trough, and means to draw a sheet of glass substantially horizontally and on edge from the trough.

Timing mechanism for glass feeders. OLIVER MOORE TUCKER AND WILLIAM ALBERT REEVES. U. S. 1,760,999, June 3, 1930. In a timer mechanism for glass-working machinery, valves controlling the operation of the machinery, a revolving member adapted to actuate the valves, and means for shifting one of the valves in an arc concentric with the axis of rotation of the revolving member, whereby the relative time of actuation of the valves may be varied.

Glass tank furnace. WILBUR F. BROWN. U. S. 1,761,190, June 3, 1930. A glass tank furnace adapted to contain a mass of molten glass and including a cooling chamber, a draw pot abutting the cooling chamber, means arranged at the juncture of the draw-pot and cooling chamber for preventing the molten glass from leaking from the furnace at this point, and means for moving the first-named means vertically and horizontally to force them against the draw pot and cooling chamber.

Sheet glass-handling device. JOSEPH P. CROWLEY. U. S. 1,761,193, June 3, 1930. Apparatus for handling sheet glass including a substantially U-shaped frame comprising a member substantially the length of the sheets to be handled, arms projecting at substantially right-angles from the member adjacent the opposite ends thereof only, and being disconnected at their outer ends, and a plurality of flexible suction cups carried by the member and arms.

Forming sheet glass. JOHN L. DRAKE. U. S. 1,761,195, June 3, 1930. In sheet

glass-drawing apparatus, a pot containing molten glass, means for drawing a glass sheet therefrom, a plurality of horizontal and vertical coolers arranged on each side of the glass sheet and coöperating to form a cooled hood-like structure above the portion of the molten glass from which the sheet is drawn for artificially maintaining the portion of molten glass at a relatively low temperature, and means for maintaining a supplying source of molten glass, on each side of the portion of molten glass, at a sustained relatively high temperature.

Sheet glass-surfacing apparatus. JOHN L. DRAKE. U. S. 1,761,196, June 3, 1930. The combination with a table adapted to support a glass sheet to be surfaced, of a plurality of groups of surfacing members resting upon the glass, a second plurality of groups of surfacing members also resting upon the glass and arranged alternately with the first-named groups of surfacing members, the surfacing members of the second-named groups being smaller than the surfacing members of the first-named groups, and means for effecting the rotation of all of the groups, the surfacing members of the second-named groups intermeshing with the surfacing members of the first-named groups.

Glass tank-furnace construction. JOHN L. DRAKE. U. S. 1,761,197, June 3, 1930. A jack-arch construction comprising a body portion adapted to be rigidly mounted in a glass furnace, link members carried by the body, and a slab supported by the links.

Drawing sheet glass. JOHN L. DRAKE. U. S. 1,761,198, June 3, 1930. The process of producing sheet glass from a mass of molten glass, consisting in drawing a tapered sheet therefrom, and then contacting with and deflecting the sheet at that point which will give the desired thickness.

Sheet glass-handling apparatus. JOHN L. DRAKE. U. S. 1,761,199, June 3, 1930. In sheet glass-handling apparatus, a plurality of idler rollers for supporting a moving ribbon of glass, and a plurality of driven rollers rotatable in the same direction as the idler rollers for carrying away a sheet of glass after it has been cut from the ribbon at a speed relatively greater than the movement of the ribbon.

Producing sheet glass. JOHN L. DRAKE. U. S. 1,761,200, June 3, 1930. In apparatus of the character described, a pair of receptacles, a main cap, and a pair of auxiliary caps, one of the receptacles being receivable under the main cap and the other under one of the auxiliary caps, heating means associated with the main cap for producing a mass of molten glass in the receptacle thereunder, means for forming a sheet from molten glass contained within the receptacle under the auxiliary cap, and means by which the relative positions of the receptacles may be changed at predetermined intervals.

Trifocal lens. PAUL ECKLEY. U. S. 1,761,201, June 3, 1930. The method of making a glass lens which comprises forming a depression in a base glass of a certain index of refraction, inserting a glass of another index of refraction in the depression, the insert having an annular junction surface for coöperation with an annular junction surface formed around the periphery of the depression in the base glass to provide an area of intermediate focal length between the base glass and the insert, permanently securing the glasses together and finally forming and shaping a finished lens.

Producing sheet glass. FRANK FRASER. U. S. 1,761,204, June 3, 1930. In sheet glass apparatus a tank furnace for supplying a stream of molten glass to sheet-forming means including a slotted member so constructed that the central portion of the stream will contact therewith a longer period than will the border portions as the stream flows from the tank.

Sheet glass width-maintaining device. LEOPOLD MAMBOURG. U. S. 1,761,219, June 3, 1930. In a sheet glass drawing apparatus, means for drawing a sheet from

a mass of molten glass, pivotally associated members engaging each of the sheet edges, and means for increasing the temperature of the members.

Draw pot for sheet glass apparatus. LEOPOLD MAMBOURG. U. S. 1,761,220, June 3, 1930. In sheet glass apparatus, a draw pot formed from a noncorrosive metal and having compartments therein, and means for heating the compartments.

Drawing sheet glass. CLIFFORD A. ROWLEY. U. S. 1,761,234, June 3, 1930. The method of producing sheet glass, consisting in drawing the sheet from a supply of molten glass, the drawing force being applied to the set sheet at some distance from the molten source, drawing the sheet edges from the source at points adjacent the source at a slower speed than the rate of draw of the sheet, and simultaneously but independently applying lateral or sidewise tension to the sheet edges between the source and the points of application of the edge-drawing force.

Drawing sheet glass. CLIFFORD A. ROWLEY. U. S. 1,761,235, June 3, 1930. In an apparatus for simultaneously drawing a plurality of sheets of glass, a container for a pool of molten glass, a plurality of bending members, one for each sheet, a plurality of horizontal drawing and flattening tables, a roller above each table and the sheet carried thereby for holding the sheet in engagement with the table, the tables being staggered so that the roller for a lower sheet may be positioned in substantial horizontal alignment with the table for the next upper sheet, a leer, and a plurality of superposed conveyers in the leer for individually carrying the sheets therethrough.

Making sheet glass. HARRY F. HITNER. U. S. 1,761,342, June 3, 1930. In combination in apparatus for making glass, a tank, a metal electrode constituting a part of one of the walls of the tank and having a slot therethrough, means in opposition to the slot for receiving and carrying away the glass flowing from the slot, a second electrode at a point remote from the first electrode positioned so as to transmit current to the glass in the tank at the point, and means for supplying electric current to the electrodes.

Making spherical glass bodies. JOHN F. EARLY. U. S. 1,761,623, June 3, 1930. In a machine for manufacturing spherical glass bodies, a pair of oppositely arranged rolls having at the working point opposing peripheral grooves; lands at the sides of the grooves, the grooves being disposed out of coincidence with each other with a portion of one of the lands on one of the rolls lying directly opposite a portion of the groove on the opposite roll; means for simultaneously rotating the rolls upwardly and downwardly at their respective working points, the groove on the upwardly moving roll being shallower than the groove on the downwardly moving roll, the opposite arrangement and the difference in depth of the grooves comprising means whereby the formation of the gob is accelerated and rotation about a single axis prevented.

Glassblowing machine. HANS HILLMANN. U. S. 1,761,665, June 3, 1930. In a glassblowing machine, the combination of a divided blank mold having passages disposed in the divisional planes, a coacting divided neck mold having bores to align with the passages and a central opening to align with the mold cavity, a cylinder surmounting the neck mold to form a common space in communication with the bores and central opening, means for alternately connecting the space with a source of suction and with a source of supply of pressure air, valves for automatically closing the passages during the air supply, a piston slidable in the cylinder, and a plug carried by the piston.

Sheet glass-surfacing table. JOHN C. GIPE. U. S. 1,761,720, June 3, 1930. In sheet glass-surfacing apparatus, a table having a sheet-receiving recess therein, and a pad loosely mounted within the recess for freely supporting the sheet of glass to be surfaced, the recess being of a shape to prevent turning of the pad and sheet therein.

Sheet glass-surfacing table. WILLIAM H. POWLESSON. U. S. 1,761,746, June 3,

1930. In sheet glass-surfacing apparatus, a glass supporting table, and an asbestos pad carried by the table and adapted to support the sheet to be surfaced.

Sheet glass apparatus. JESSE W. WILDERMUTH. U. S. 1,761,763, June 3, 1930. In sheet glass apparatus, a heat-absorbing member adapted to be positioned at one side of the sheet comprising a casing, a conduit extending within the casing for receiving a cooling medium and having a series of openings in the top thereof through which the cooling medium is adapted to pass into the casing and a curved deflector plate arranged above the openings for directing the cooling medium, as it issues from the conduit, downwardly along the wall of the casing adjacent the glass sheet.

Producing laminated glass. WILBUR F. BROWN. U. S. 1,761,770, June 3, 1930. The process of producing laminated glass, consisting in assembling the laminations, including a nonbrittle lamination, to be joined in proper superimposed relation, the nonbrittle lamination being of a size greater than the other laminations, then placing clamping means on the nonbrittle lamination on that part thereof extending beyond the other laminations, and arranging the clamping means in abutting association with the edges of the other laminations whereby to prevent relative movement between the various laminations.

Glass machine. MAX JAEGER. U. S. 1,761,792, June 3, 1930. (1) In a machine of the class described, a rotatable mold table, a plurality of molds associated with the mold table, means pivoted coaxially with the mold table to guide charges into the molds, means to enter the molds and form a depression in the glass to shape the charges therein and intermittently operated means to lock the guiding and shaping means in fixed angular position with respect to the mold table whereby the guiding and shaping means rotate at the same angular velocity as the mold table. (2) In a machine of the class described, a vertical column, a mold table rotatable about the column, a plurality of molds associated with the mold table, a bracket mounted for oscillatory movement about the column, a jacketed funnel supported by the bracket and adapted to guide glass charges into the molds, an air operated pressing cylinder also supported by the bracket, an exhaust line connecting the pressing cylinder with the jacket of the funnel, a second exhaust line connecting the pressing cylinder with the interior of the funnel, and an oil cup positioned to mix oil with the air exhausted through the second exhaust line. (3) In combination, a glass-feeding device, glass-shaping mechanism having an operative and nonoperative position relative to the glass-feeding device, means to set the glass-shaping mechanism in operation, and means to automatically move the glass-shaping mechanism to its operative position relative to the feeder and to change the rate of operation of the feeder from one rate to another upon actuation of the means to set the glass-shaping mechanism in operation.

Producing sheet glass. JOHN L. DRAKE. U. S. 1,762,508, June 10, 1930. In apparatus for producing sheet glass, sheet-rolling mechanism, means for supplying molten glass thereto including a receptacle adapted to contain the molten glass and a member for receiving the glass from the receptacle and guiding it to the rolling mechanism, and means for simultaneously moving the receptacle and member so that the glass will flow from the receptacle to the rolling mechanism without any fall or drop.

Laminated glass. HENRY A. GARDNER. U. S. 1,762,513, June 10, 1930. As an article of manufacture, a composite body comprising a plurality of glass sheets firmly united together by means of a nonbrittle binder containing a toluol sulphoamaldehyde resin, the binder being resistant to discoloration by ultra-violet light.

Glass-cutting device. IVAL G. FOWLER. U. S. 1,762,575, June 10, 1930. In a sheet glass-cutting device, the combination of a carrier frame beneath which the glass travels, shafts mounted in the frame and extending across the glass, cutting elements secured to the shaft respectively, individual means provided with a measuring scale

for adjusting the shafts individually in the direction of their length to bring the cutting elements the required distance apart, and additional means for effecting a simultaneous and equal adjustment of all the shafts in the direction of their length.

Manufacture of laminated glass. GEORGE W. KRETZSCHMAR. U. S. 1,762,722, June 10, 1930. An apparatus for use in preparing the edges of laminated glass for sealing comprising an endless, traveling band cleaner, means to support the band cleaner, a movable supporting table to receive the sheet of laminated glass, a presser mounted on the table to press the glass down on the table, means to actuate the presser mounted on the table, and means to move the table and the presser toward the band cleaner.

Glassware annealing leer. ALBERT N. CRAMER. U. S. 1,763,223, June 10, 1930. A leer for annealing glass articles comprising an annealing chamber extending lengthwise of the leer, a conveyer extending through the chamber lengthwise thereof, a heating device adjacent one end of the chamber, and means for causing a continuous circulation of air through the heating device for heating the air and then through the annealing chamber in the direction of its length and back to the heating device, the circulating means including a suction box extending transversely of the annealing chamber and provided with openings extending through the floor of the chamber and distributed transversely of the chamber.

Strengthened glass. H. D. MURRAY AND D. A. SPENCER. Brit. 327,121, May 21, 1930. In a composite glass of the type wherein a layer of flexible transparent material is mounted between glass elements, the flexible layer is formed of regenerated cellulose which is built up of two or more layers united by a binder (*e.g.*, an emulsified colloid such as gelatine or water soluble gum), and impregnated with one or more plasticizing agents, *e.g.*, a neutral nonvolatile viscous liquid such as glycerol or a solid such as glucose yielding from solution a nonbrittle residue. Preferably two or more plasticizing agents are used. The regenerated cellulose may be obtained from solutions of cellulose such as cellulose xanthate by decomposition thereof with a suitable acid or salt. The regenerated cellulose may be produced in situ on the glass elements. *E.g.*, glass plates with a substratum of gelatine, water soluble gum, etc., may be coated with viscose which is then decomposed, preferably in the presence of a colloid or a sugar, to deposit the cellulose on the glass. Alternatively, films of regenerated cellulose may be rolled or otherwise applied to the glass elements in the presence of the impregnating solution, or a number of such films may be impregnated and consolidated to form a compound sheet which is then mounted between the glass elements. The impregnation is preferably effected at a temperature of from 40 to 60°C which is maintained for 10 to 15 minutes. To prepare the cellulose films, a solution of cellulose xanthate ripened for 7 to 10 days is spread over a prepared glass surface, coagulated with hot ammonium sulphate solution, washed with water, dried, and then stripped from the glass. The mounting of the elements of a composite glass is preferably effected in the presence of two liquids, one of which, such as glacial acetic acid, is capable of solvating the gelatine substrata on the glass and in the flexible element, and the other, such as ethyl alcohol, is capable of penetrating the substrata without causing them to swell or dissolve. In one example, a solution of cellulose xanthate which had ripened from 7 to 10 days is filtered, the concentration being such that the solution just flowed freely over a glass surface. The glass plates are covered with a 10 per cent solution of gelatine, dried, the xanthate solution applied, and the plates immersed in a coagulating medium consisting of an aqueous solution of 5 parts of hydrated disodium hydrogen phosphate, 10 parts of hydrated sodium sulphate, 15 parts of sodium chloride, 10 parts of glucose, and 100 parts of water. When coagulation is complete, the plates are washed placed in a bath of 95 parts of water and 5 parts of concentrated hydrochloric acid, then in a bath containing 90 parts of water and 10 parts of sodium sulphate, then washed

with water, dried superficially, and immersed for five minutes at 40 to 50°C in a bath composed of 85 parts of water, 15 parts of glycerine, and 10 parts of gelatine. The plates are then removed, dried, and mounted under a mixture of 15 parts of glacial acetic acid and 90 parts of alcohol (industrial spirit), the jointing being effected under pressure at a temperature of 40°C. In a second example, a film of regenerated cellulose is spread on gelatine-coated glass plates under a mixture of 100 parts of gelatine, 100 parts of glucose, 192 parts of glycerine, and 850 parts of water, at about 50 to 60°C the operation being repeated until a film 5/1000 in. thick is formed on each plate. The plates are then dried and pressed together as before. In a further example, a number of films of regenerated cellulose giving a total thickness of 10/1000 are pressed together under a solution of the same composition as in the preceding example, and the compound sheet dried in air and mounted between gelatine-coated glass plates under pressure and gentle heat in a bath of acetic acid and alcohol as in the first example. In another example, the impregnated film is mounted between clean glass plates which are chemically etched in any known manner.

Spectacle lenses. UNITED KINGDOM OPTICAL CO., LTD., E. CULVER, AND A. H. EMERSON. Brit. 327,752, June 5, 1930. Bifocal lenses comprise a lenticular support having two or more lens inserts of different focal power, the inserts having a greater refractive index than the support and merging into one another. The optical centers of the inserts are normally located in a plane passing through the vertical meridian of the support.

Grinding, etc., machines. J. BATH. Brit. 327,852, June 5, 1930. In a grinding machine, lubricant is supplied to the grinding wheel and work both above and below the cutting point, and means may be provided for shutting off the flow when the work ceases to rotate and for turning it on again as soon as the rotation is resumed. The lubricant is supplied by a pipe having branches, and a valve controls the amounts passing to those branches; a valve also is provided to control admission of lubricant to the device and is operated by the plunger of a solenoid and by springs, the solenoid being in the circuit of the work-rotating, or work-rotating and table-operating mechanism, so that the flow of lubricant is started or stopped with the rotation of the work.

Glass furnaces. A. J. DELMOTTE. Brit. 327,868, June 5, 1930. A series of cooling tubes is arranged round the interior of a glass melting tank with the object of forming a protective layer of solidified glass on the walls. The pipes may be arranged over the whole height of the walls, or at the upper part only, and when water is used as the cooling fluid safety valves are provided for the escape of steam.

Glass. CHANCE BROTHERS & CO., LTD. Fr. 671,307, March 12, 1929. The "fading" of glass which allows passage of ultra-violet rays, is reduced to a minimum by avoiding the use of substances that cause the formation in the finished glass of dissolved gaseous oxides. An example of a suitable composition contains SiO_2 560, borax 527, and Zn in powder 8 parts. Zn may be replaced by Al or Sn. (*C.A.*)

Glass. CORNING GLASS WORKS. Fr. 673,436, April 16, 1929. A heat-absorbing borosilicate glass is made by melting under reducing conditions a composition containing Si, B, one or more metals of the 2nd group having an atomic weight between 60 and 120, and Fe. An alkaline earth may also be added. Examples are given using ZnO or CdO. Fr. 673,437 describes a process for modifying the color of glasses containing an element of the 2nd group, the atomic weight of which is between 20 and 140, a substantial amount of Fe in the ferrous state and a reducing agent, by the addition of a small quantity of Sn or substance containing Sn. The glass obtained has a relatively high absorption for the infra-red, ultra-violet, and visible red and a relatively high transmission for the rest of the visible spectrum. See also *Ceram. Abs.*, **8** [10], 731–32 (1929). (*C.A.*)

Glass. CORNING GLASS WORKS. Fr. 673,481, April 17, 1929. An opaline glass suitable for electric lamp bulbs contains, *e.g.*, SiO_2 55.6, Na_2O 10.5, Al_2O_3 7.5, CaO 4.6, B_2O_3 11.2, F 3, and ZnO 7.5. See preceding patent. (*C.A.*)

Reënforced glass. SOC. ANON. DES MANUFACTURES DES GLACES ET PRODUITS CHIMIQUES DE SAINT-GOBAIN, CHAUNY ET CIREY. Fr. 673,668, Aug. 14, 1928. The glass of reënforced glass sheets is united to the central sheet of cellulose material by a synthetic resin such as PhOH-CH_2O, urea-CH_2O, or glycerol and phthalic anhydride resins. The resin is applied in solution to the glass, dried and polymerized, and the glass sheets are pressed onto the sheet of cellulose material in a solvent for the latter. (*C.A.*)

Safety glass. ROBERT P. F. V. HAMOIR. Fr. 673,711, Aug. 23, 1928. The sheets of glass and celluloid with the solvent thereon are united by heating in a high vacuum. (*C.A.*)

Safety glass. DU PONT VISCOLOID CO. Fr. 673,972, April 24, 1929. Safety glass which does not become discolored contains no camphor, or at most 12%, in the cellulose layer; plastifying agents or solvents of high boiling point such as AcOAm, triacetin, or glycoethylene diacetate are used. (*C.A.*)

Safety glass. POLLOPAS, LTD. Fr. 674,880, May 10, 1929. The layer between the two sheets of glass is composed of limpid polymerization products made by condensing organic compounds such as vinyl esters with or without aldehydes. (*C.A.*)

Annealing furnaces. H. SCHAEFER & CO. Fr. 674,926, May 11, 1929. In a closed annealing furnace having traveling carriers, the vacuum formed on cooling is filled by inert gases such as lighting gas. (*C.A.*)

Safety glass. LOUIS J. KOLB. Fr. 675,587, May 22, 1929. Method of sealing the edges of foliated sheets of glass and celluloid. (*C.A.*)

Uniting glass plates. CONSORTIUM FÜR ELEKTROCHEMISCHE INDUSTRIE G.M.B.H. Fr. 676,299, June 6, 1929. Objects such as glass plates are united by a layer of a solution of a polyvinyl ester such as polyvinyl acetate. (*C.A.*)

Translucent glass. PATENT-TREUHAND-GES. FÜR ELEKTRISCHE GLÜHLAMPEN M.B.H. Ger. 488,629, Nov. 11, 1927. To produce highly translucent glass bulbs, etc., clear-glass powder is mixed with small amount of such pearling or coloring agents as Al_2O_3, TiO_2, or ZrO_2. (*C.A.*)

Glass. CHEM. FABRIK STOCKERAU FELIX POLLAK. Ger. 490,511, Jan. 3, 1928. Glass threads are drawn from molten glass by nozzles heated electrically and protected by tubes of fireproof material. (*C.A.*)

Glass. NATHAN KAMINSKI. Ger. 492,004, April 21, 1927. Glass in which fine bubbles of air are enclosed is prepared by mixing molten glass with air under pressure and reducing the pressure as the temperature falls. (*C.A.*)

Safety glass. JOHN TALBOT. Fr. 674,223, April 29, 1929. A sheet of glass is coated on both sides with a solution of gum arabic, water, glycerol, and AcOH and, when this is dry, with a 2nd coating of gum elemi, acetone, alcohol, AcOEt, Canada balsam, and benzene. The coated sheet is placed between 2 sheets of cellulose acetate or celluloid treated with a solution of alcohol, acetone, Canada balsam, benzene, and gum elemi, and the 3 are pressed together. (*C.A.*)

Heavy Clay Products

Notes on brickmaking. GROSSKINSKY. *Tonind.-Ztg.*, **54** [33], 559–60 (1930).—Brick lose their mechanical solidity and other qualities from over-drying, or smoking for too long a period, which cannot be restored by strong refiring. The cohesion power of the clay particles of dry brick is lowered and the sound is not as good as that of brick

dried regularly. Well predried brick which contain only a small quantity of hygroscopic water must be drawn into the preheating zone a few hours after being placed in the kiln. Brick dried in air must be well smoked and immediately drawn into the preheating zone or the zone of flue gases. It is also observed that well dried brick removed from the drying chamber and stored, absorb humidity again out of the air. It is a mistake to throw back into the pit brick scraps which were dried above 80°C. Clay heated above 80°C loses its binding power and can be used only as a thinning agent. M.V.K.

Moler brick. H. FISCHER-MÖLLER. *Tonind.-Ztg.*, **54** [25], 421–24; [26], 441–43 (1930).—In Denmark, a light, porous brick of great solidity and insulating properties is manufactured from moler. Raw moler is a diatomaceous earth consisting of small unicellular organisms, plants, and silicic seaweeds with a slimy liquid. The wall of each cell is mainly silicic acid. One cu. m. of dried raw moler weighs about 580 kg. showing that it does not consist of loam or clay, as it is three times lighter than earth. Dried moler is white or light gray. Large beds of volcanic sand are found in moler deposits, mainly of blackish or yellowish color. Sometimes beds or lumps of the so-called cement stone are present, formed from the lime in the pores. The fusing point of moler is 1200 to 1250°C. At this temperature the greatest solidity and a beautiful red color were obtained. A cube fired at 1230° gave a resistance to pressure of 342 kg./sq. cm. Shrinkage from firing is 11%. The chemical composition of moler is 67.8% SiO_2, 6.7% Al_2O_3, 5.5% Fe_2O_3, 1.2% CaO, 0.9% MgO, traces CO_2, 0.6% SO_3, 7.4% loss on ignition, and 8.3% hygroscopic water. Specific gravity is between 0.87 and 1.13 depending on the firing temperature; the figure of thermal conductivity is 0.15 to 0.16. The brick are made hollow as moler dries with difficulty. The adhesion of porous moler raw material to concrete is very great, while its heat-insulating properties make it valuable for use in kilns. Condensation phenomena do not appear in steel construction with moler. A description of the brick plants is given. The production amounts to 11 million brick per year and great quantities are exported to England and Germany. M.V.K.

Structural clay by a new process. JOSEPH B. SHAW AND MYRIL C. SHAW. *Arch. Rec.*, **67** [4], 396 (1930); see *Ceram. Abs.*, **9** [6], 427 (1930). E.B.H.

Gypsum in clay. ANON. *Tonind.-Ztg.*, **54** [29], 494 (1930).—Gypsum acts injuriously only when it is present in clay products after firing. Gypsum can be decomposed by reduction or by firing at high temperatures (Seger cone 6a), at which temperature other ingredients of the mass react with CaO forming compounds and hastening the decomposition. If a body containing gypsum is dried slowly and fired at Seger cone 8, a yellow, brownish, and sometimes red color can be seen along the edges. An addition of barium carbonate prevents coloring. Sometimes during the drying process gypsum reaches the surface of the body and gives a good color to the vitrified surface. Gypsum in clay is desirable in special cases. M.V.K.

Efflorescences caused by diluting water. ANON. *Tonind.-Ztg.*, **54** [30], 510–11 (1930).—Investigations to find the cause of efflorescences on fired brick of good quality manufactured at a German plant revealed a high SO_3 content in the pond water used for production. M.V.K.

Some causes and consequences of florescence on brickwork. W. ANGUS MCINTYRE. *Clay Craft; Ceram. Age*, **14** [2], 52–57 (1929); see *Ceram. Abs.*, **8** [1], 31 (1929). W.W.M.

Unusual kiln scum. H. B. HENDERSON. *Jour. Amer. Ceram. Soc.*, **13** [7], 458–60 (1930); for abstract see *Ceram. Abs.*, **9** [3], 183 (1930).

Avoiding defects in brick production. A. PELLACINI. *Corriere ceram.*, **11** [4], 145–47 (1930).—The principal causes of defects in clays are improper preparation in-

cluding insufficient mixing and unequal distribution of moisture, and lack of storing. sometimes the clay mass contains small stone fragments which can be eliminated by the use of steel cylindrical refiners. M.V.K.

Modern efficiency in brick production. J. B. NEALEY. *Ceram. Age*, **14** [6], 17–20 (1929).—A description of the manufacturing process of the Claycraft Mining & Brick Co., showing the efficiency of gas-fired tunnel kilns and other modern equipment. W.W.M.

Heavy clay investigation. ANON. Bur. Stand., *Tech. News Bull.*, No. 157, p. 46 (1930).—The P.C.E. value of 10 shales found in Ohio ranges from 1 to 11, seven glacial clays from 3 to 11, and 8 alluvial clays from 4 to 12. R.A.H.

Brick, their preparation, use, and tests. ANON. *Tonind.-Ztg.*, **54** [40], 684 (1930); for abstract see Giles, *Ceram. Abs.*, **9** [7], 528 (1930). M.V.K.

Convert off-grade ware by correct fuel application. ANON. *Brick Clay Rec.*, **76** [11], 716–17 (1930).—Clay products manufacturers are beginning to find a solution to the problems of under-fired and off-grade ware by using a pulverized fuel which is mixed with the brick which are set in those positions in a kiln most likely to be under-fired. These coal brick save not only fuel but convert what might otherwise be an off-grade ware into a first quality product. Another use for fueling brick and other clay products is to produce a lighter weight product. A few manufacturers have even found that the mixing of coal to their brick has produced new colors and textures and has given them an advantage by making it possible to produce a wider range of product. E.J.V.

Shrinkage of brick with short firing range. ANTON VOGT. *Clay-Worker*, **93** [6], 413 (1930).—The shrinkage (settle) of such brick must necessarily be slow, with only sufficient heat that the brick will stand under weight. If the top brick begin to shrink at 1760 to 1800°F, it proves that a whole kiln of brick can be fired to a uniform settle from top to bottom if the heat is not increased on top, but this requires more time and also more fuel. It is only a matter of more time and fuel, until every brick in the kiln is thoroughly penetrated with sufficient heat, and then every brick will shrink. No uniform settle is possible until the above condition exists, and therefore heating the whole kiln of brick, that easily overfires, is the right way to settle, slowly, gradually. E.J.V.

Long fissures in pipes. ALFRED OLSEN. *Lerindustrien*, **2**, 10–11 (1930); *Tonind.-Ztg.*, **54** [9], 155 (1930).—Long fissures appear most frequently in pipes of more than 10 cm. interior width. One reason for this is an insufficient preparation of clay. For all products with thin walls, the weathering of clay is a preliminary condition. This decomposes the clay so that it can be worked into a homogeneous mass. Fissures may also be caused by a wrong method of drying. The surfaces of drain pipes dry first and shrink, while the interior remains unchanged. Tensions and long fissures result in the dry outside shell. These fissures can be found immediately by rapid drying. With slow drying they are not seen till after firing. The thicker and finer the clay material, the greater is the difficulty of evaporating water from the interior of the walls of the pipe. Large pipes are usually dried in an upright position, but the outside surface dries quicker than the inside surface. This can be partly counteracted by a uniform circulation of air through the inside of the pipes. Freshly molded pipes should be placed in a horizontal position as soon as possible so that the dry air can reach the outside and inside surfaces simultaneously. Tensions may appear also when the dried pipes are stored in damp autumn air awaiting a later firing, and their outside surfaces absorb moisture from the air, causing the clay to expand. A long fissure appears on the dry inside surface. Fissures may also be caused by firing, especially in annular kilns where the pipes are placed vertically. In this case the air moving hori-

zontally strikes only one side which dries and shrinks before the rest of the pipe, causing tensions and so, fissures. If possible the pipes should be fired lying. In continuous kilns with alternate flame the fissures result when the pipes are fired lying as the fire moves in a vertical direction. In such kilns the ware should be fired standing.

M.V.K.

Test of composite beams and slabs of hollow tile and concrete. D. E. PARSONS AND A. H. STANG. Bur. Stand., *Jour. Research*, **4** [6], 815–49 (1930).—Sixty reinforced beams, 12 concrete and 48 composite beams representing portions of concrete and hollow tile slabs, were fabricated and tested in the laboratory to determine the value of the tile in assisting the concrete to resist shear and bending. Among the variable features entering into the construction of the beams were included tile of different qualities and weights and differences in their position in the beams. The shearing strength of the bond between concrete and hollow tile was determined also by the testing of 120 specimens representing small portions of hollow tile and concrete slabs. The results of the beam tests indicated that one row of tile was equivalent in resisting shear to a concrete rib of the same depth and having a width of from 1.6 to 2.4 inches. At loads considerably less than the maxima, the tile were more effective in increasing the resistance of the beams to bending deformations than at higher loads. The relatively lower values for the higher loads are believed to be due, at least in part, to partial failure of the bond between the concrete and tile. The strength in shear of the bond between concrete and hollow tile was found to be affected by the factors having an influence on the compressive strength of the concrete. This strength was greatest when concrete containing the least amount of water necessary for its proper placement was used in combination with dry or slightly dampened tile. The results indicated that the methods followed in the construction and aging of the beams were not favorable to the development of as strong a bond as would have been obtained by different methods.

R.A.H.

Work tests on brick. O. DRÖGSLER AND K. DRÖGSLER. *Tonind.-Ztg.*, **54** [10], 157–58; [11], 177–78 (1930).—The authors made tests on 10 different kinds of brick to determine (1) the strength of cubes, (2) strength of the bodies according to OE standards, (3) solidity of two loose brick halves one on top of the other, (4) solidity of brick halves one on the other (12 x 12 cm.), (5) resistance to pressure of whole brick, and (6) toughness and tensile strength according to standards. Tables, charts, and diagrams give data. These will suggest to the manufacturer a means of making a comparative valuation of his products.

M.V.K.

Brick plant power test. EDWARD E. KRAUSS. *Clay-Worker*, **93** [6], 414–21 (1930).—Power readings were made on the entirely motorized plant of the Bohnsack Brick Co., Chicago, Illinois, which produces 300,000 stiff-mud brick per day of eight hours from surface clay. Tests were made to secure information on the following points: (1) was each motor, as installed, of the proper size and general characteristics to best serve the particular driven unit; (2) could customary operating conditions be changed to reduce power consumption or shock to motor or driven unit; (3) comparison of power consumption of an auger machine with a relative test of plasticity or workability of a particular clay; (4) to secure a picture, by means of charts, of the changing power requirements of a particular machine in its cycle of operations. Operating conditions during tests, method of conducting tests, and apparatus used are enumerated. A discussion of the information revealed by the tests, derived from typical charts covering the various machines, is presented with the charts. Illustrated.

E.J.V.

Ratios of wall strength to brick strength. L. B. LENT. *Bldg. Econ.*, **5** [11], 20 (1929).—The only strength property of individual brick which bears any definite or uniform relation to resulting wall strength is the compressive strength of the brick as

laid in the wall (usually flatwise). No other strength properties, such as transverse, tensile, or shearing, seem to have any very definite relation to resulting wall strengths. E.P.R.

Low heat losses for clay masonry walls. ANON. *Brick Clay Rec.*, **76** [11], 703 (1930).—In a report on heat losses in house walls, brick construction is favorably spoken of. A comparison of seven different types of walls is made. Illustrated. E.J.V.

Engineers study stains on structural materials. ANON. *Pit and Quarry*, **20** [5], 70 (1930).—The Western Society of Engineers recently formed a Mineral Industries Section. The first meeting of the Society under the auspices of this section was held May 26, when H. C. Peffer, head of the School of Chemical Engineering, Purdue Univ., spoke upon "Staining and Efflorescence of Building Stone and Other Materials." He proves that such blemishes on buildings are due exclusively to the invasion, by water, of the construction materials that lie above or behind the face material. Such water dissolves salts from the other materials and the solutions migrate, by capillarity or hydrostatic pressure, through the pores of the facing materials, frequently absorbing other substances from the stone or brick, until the exterior of the wall is reached where evaporation takes place, and the chemicals remain as bloom on the surface. Rational architectural design and engineering construction will positively forestall such blemishes. E.P.R.

Bulwarks of engineering practice. HUGO FILIPPI. *Brick Clay Rec.*, **76** [11], 705–10 (1930).—Brick masonry is susceptible to and controlled by the same basic principles of mechanics as are all other comparable types of masonry construction. The factors which influence the strength of brickwork are known and can be controlled. This advanced state of knowledge has given rise to a new classification in the field of engineering mechanics and brick engineering, which may be defined as "the science of producing structurally safe and economical brick masonry through a proper combination of intelligent design, suitable materials, skilled workmanship, and adequate inspection." Some interesting information about the engineering advantages of common brick is presented. This includes data on compressive strength, modulus of rupture, adhesion of mortar to brick, effect of shape of brick, strength of mortar, absorption of brick, weather resistance of brick, and efflorescence. E.J.V.

Hazleton Brick Co. develops light-weight plaster block. ANON. *Brick Clay Rec.*, **76** [11], 699 (1930).—The Hazleton (Pa.) Brick Co. has developed a new light-weight partition and plaster block, the use of which eliminates the brown mortar cost, and thus substantially cuts down construction costs. The new block is composed of 37% hard-fired clay (ground brick bats), 37% clinkers of hard coal with all ash screened out, 20% Portland cement, and 6% gypsum plaster. The fired clay products and coal clinkers are ground fine enough to pass a $^3/_{16}$ in. screen. All the loam is screened out with a fine screen, the materials are mixed and formed into blocks which run from 3 x 8 x 16 in. to 12 x 8 x 16 in. in size. The finished blocks have the same appearance as finished brown mortar and have a crushing strength of approximately 1400 lbs. per sq. in., with an absorption test of 6%. The approximate weight of 3-in. partition blocks is 16 lbs. per sq. ft. Illustrated. E.J.V.

Story of a modernized plant. ANON. *Clay-Worker*, **93** [6], 405–11 (1930).—A detailed account of plant No. 4 of the Claycraft Mining and Brick Co. at Taylor, Ohio, is given. This plant has been modernized since it was purchased by the present owners, and where it formerly produced 75,000 common brick daily during six months of the year it now produces 100,000 daily, divided between common and face brick. Equipment and methods of operation are described in detail. The annual production of the company is 65,000,000 brick, which includes a high-grade line of practically all colors

in glazed brick, smooth and rough texture face brick, and red common brick. Illustrated. E.J.V.

Brick standards reduce production cost. J. F. McNeil. *Commercial Stand. Monthly*, **6** [11], 335 (1930).—A survey of production, in the rough and smooth face brick and common brick industry, conducted in 1922, showed 39 sizes of rough face brick, ranging in length from $7^3/_4$ to $8^5/_8$ in., in thickness from $2^1/_8$ to $2^3/_4$ in., and in width from $3^3/_{16}$ to $4^1/_2$ in. In the manufacture of smooth face brick there were found to be 36 variations in size. Forty-four sizes of common brick were also in existence at that time. The established recommendation reduced the variety of rough and smooth face brick from 75 sizes and types to 2; and of common brick from 44 to 1. A check has revealed that 93% of the face brick and 85% of the common brick is made in accordance with the simplified schedule. Outstanding benefits cited by acceptors of the recommendation are smaller inventories, lower production cost, necessity for less yard space, quicker turnover, and a more satisfactory condition regarding competition, as all competitors are put on an equal basis. Excerpts of replies from manufacturers are given. E.J.V.

"Guesstimating" in the modern brick plant. Anon. *Clay-Worker*, **93** [6], 423 (1930).—The trend in the modern brick plant is to meter everything of importance that can be metered. It has been found that it pays to know all about the steam, the CO_2, the draft, temperatures, and fuel in an establishment regardless of size. Much fuel is saved as the result of the eliminating of guesswork in plant operation. E.J.V.

Brick for city streets and interurban highways. Harry C. McClure. *Clay-Worker*, **93** [6], 430–32 (1930).—It appears that the nearly ideal pavement would be one with (1) the subsoil of adequate natural drainage, or treated so that equally good drainage would be afforded and (2) a foundation suitable for loads much heavier than the present-day traffic regulations will allow, moving at still greater speeds. All edges subject in the slightest degree to what might be termed a cantilever action, thickened or reënforced so that these strips or areas of greater strain would be somewhat more amply protected than the general surface of the foundation slab; (3) the slab, machine or hand-finished to a uniform contour and surface, slightly granular, but not rough. On this, a $^3/_4$ or 1-inch bed of sand and cement, limestone screenings or granulated slag of uniform consistency, composition, and moisture; this cushion bed to be rolled with a heavy hand roller or light power roller to disclose any slight uneven area in the sand bed, with all depressions after rolling, built up and rerolled before the brick surface is applied; (4) brick of $2^1/_2$ or 3-inch depth, selected for uniformity of size and firing, and passing all of the standard tests for hardness, toughness, etc., laid with fairly close joints, rolled with a roller of 3 to 5 tons weight; all broken, twisted, warped, or otherwise unsuitable brick removed or replaced, and then filled with an asphalt filler especially designed for this particular work, and the surface immediately covered with a thin coating of coarse, sharp sand. E.J.V.

Startling effects with clay products. Anon. *Brick Clay Rec.*, **76** [11], 705 (1930).—Illustrations of some interesting decorative effects worked out with brick and clay products are presented. These include statues and use of different colored brick to produce various effects. E.J.V.

Common brick in apartment field. Anon. *Bldg. Econ.*, **5** [9], 16 (1929).—Common brick are beginning to win recognition in the apartment field in many of the larger cities and recently one of the modern coöperative apartments in New York City, the Yorkgate, was built. E.P.R.

Ideal hollow walls in Flemish bond. Anon. *Bldg. Econ.*, **5** [9], 8 (1929).—The All-Rolok Ideal Wall in Flemish bond is a type of hollow wall in which the exterior brick are laid on edge instead of flatly in the conventional style. It is stronger than any

other type of masonry hollow wall, has the air chamber feature provided by a hollow tile back-up and insures equal dryness. E.P.R.

Colonial design in skyscrapers. ANON. *Bldg. Econ.*, **5** [8], 4 (1929).—Colonial atmosphere amid a setting of steel and brick towers of conventional design is rare in skyscrapers. A Philadelphia bank building construction shows the influence of old Christ Church. The high arched windows and brick pilasters are reproduced in every line. The brick have the same color tones and the masonry seems identical. E.P.R.

Forecasting wall effects. E. F. PLUMB. *Brick Clay Rec.*, **76** [10], 654–56 (1930).—A new method has been conceived of constructing display panels quickly, easily, and cheaply in any wall effects that a skilled mason could build with mortar and face brick. Color photography and printing on stiff paper produce exact reproductions of face brick in one-half sizes which units may be used interchangeably to produce any wall effects. The Fotowal has many advantages: (1) costs much less than a similar brick display; (2) presents possibilities of much wider variation in brick, mortar joints, patterns, etc.; (3) it is much lighter in weight making it more convenient for the salesman to carry and less expensive to ship; (4) it shows sufficient brick to give a true wall effect; (5) it has attraction in sales interest gained by the novelty of the idea; (6) it can be constructed easily and quickly thus making it possible to execute any rush requests for special patterns with much more speed than could be done with the regular panel; (7) it aids the building prospect to narrow down his choice. Illustrated. E.J.V.

Architects register common brick preference. ANON. *Bldg. Econ.*, **5** [11], 4–8 (1929).—Common brick's steadily increasing popularity has not been so emphatically demonstrated in years as it was by the results of the recently completed national architectural competition conducted through the active coöperation of the newspapers of the country at large under the auspices of the Home Owners' Institute of New York City. Twenty-five of the 39 prize winning homes were of common brick. E.P.R.

German brickwork. ANON. *Bldg. Econ.*, **5** [4], 10 (1930).—Brick has long been a favorite exterior material in Germany and a masonry has long been a fine art. Many typical German brick structures are illustrated and described. E.P.R.

Brickwalled graves reveal secrets of 5000 years ago. ANON. *Bldg. Econ.*, **5** [4], 6 (1929).—Discoveries which shed entirely new light upon the customs of the ancients of 5000 years ago have been made by the University of Pa. British Museum expedition in the excavations at Ur of the Chaldees. E.P.R.

Atwater Kent plant of common brick. ANON. *Bldg. Econ.*, **5** [8], 14 (1929).—Exterior wall construction of the new plant is of solid brick, the exterior facing being of a rough textured red face brick with a backing up of hard-fired commons. The window sills, coping, and other trim is of terra cotta which harmonizes with the brickwork. The exterior walls are further diversified by the use of sunken panels and various patternwork designs. E.P.R.

Great brick altar found in Mekal temple. ANON. *Bldg. Econ.*, **5** [6], 12–14 (1929).—An interesting ancient brick construction was uncovered in Beisan, Palestine, Canaanite stronghold more than 3500 years old. E.P.R.

Monster brick found in Beth-Shan migdol. ANON. *Bldg. Econ.*, **5** [3], 9–10 (1929).—Brick of heretofore unknown proportions have been discovered recently in the ruins of a one-time mighty Canaanite fortress on the site of ancient Beth-Shan, in Palestine. These brick measure 42 x 21 x 6 in. They were specially made for the purposes for which they were used. E.P.R.

Roman brick industry. E. D. VAN WIJEGAARDEN. *Klei*, **22** [8], 87–93; *Tonind.-Ztg.*, **54** [36], 619 (1930).—In a series of articles on the history of brick and tile, W.

describes the old Roman industry, the raw materials used, shaping, drying, and firing. M.V.K.

General building construction with slag concrete. ANON. *Pit and Quarry*, **19** [5], 68–70 (1930).—The National Slag Assn. of Cleveland is publishing a series of symposiums describing the characteristics and uses of blast-furnace slag. Symposium No. 12, entitled "General Building Construction with Slag Concrete," quotes statements made by well-known authorities, articles from various engineering magazines and technical papers, on this subject. E.P.R.

Coquina rock from Florida subject of building experiments. ANON. *Pit and Quarry*, **20** [4], 32 (1930).—New York structural engineers are making tests of Florida coquina with a view to developing the stone for use in northern climates. Coquina is one of the lightest stones in the world and is so soft that it can be cut with a hand saw. The cost of quarrying is said to be less than the cost of quarrying limestone, marble, or sandstone. The purpose of the experiments is to harden the stone and lessen its porosity. Coquina, in its natural state absorbs great quantities of water, which does no harm in Florida, but which, in the north, freezes and expands, cracking the stone. E.P.R.

BULLETIN

Physical Properties of Common and Face Brick Manufactured in Virginia. JOHN W. WHITTEMORE AND PAUL S. DEAR. *Virginia Polytechnic Inst. Bull.;* reviewed in *Brick Clay Rec.*, **76** [10], 662 (1930).—The material submitted for testing was numbered so that in the published results, the name of the manufacturers has not been divulged. The material has been tested for absorption, flexure or cross-breaking, crushing or compression, and for ability to resist the action of alternate freezing and thawing. Fifty-four samples were tested in this manner and the detailed results are published. E.J.V.

PATENTS

Automatic means for hacking brick. RAYMOND C. PENFIELD. U. S. 1,760,993, June 3, 1930. That improvement in the art of manufacturing brick which consists in subdividing a slug of clay of indeterminate length into slugs of predetermined length, taking each slug of predetermined length as it is formed and gradually increasing the speed of travel thereof until it reaches a collecting point, forming the on-coming stream of slugs of predetermined length into a group of parallelly arranged slugs, then moving the group of slugs transversely of the length of the slugs while maintaining the same in a horizontal plane and simultaneously subdividing the plurality of slugs into brick and then automatically and mechanically arranging the brick in hacked relation to each other preparatory to forming a kiln.

Manufacture of cellular building materials. LOUIS DESMARQUEST. U. S. 1,761,108, June 3, 1930. A method for manufacturing cellular building materials having a light, heat insulating, and highly resistant structure comprising the steps of admixing refractory clay with hydraulic cement and a gas-generating powder such as aluminum powder, adding water and thoroughly intermingling the ingredients to form a slip, casting the slip into properly shaped and sized molds, allowing the molded masses to set and contract, demolding, and allowing the blocks so molded to dry, and baking the molded and dried blocks at a temperature sufficient for dehydrating the cement and vitrifying the ingredients in the mass.

Clay texturing and coloring apparatus. ROBERT B. KEPLINGER AND PAUL A. KANENGEISER. U. S. 1,761,631, June 3, 1930. In apparatus for texturing clay products which includes means for moving a clay column, a sled including a plane inner surface adapted for being pressed against the side of the moving column, and a curved

inner surface connecting with the plane surface and forming with the side of the moving column a reservoir for comminuted material.

Brick, etc. F. P. JONES. Brit. 327,247, May 21, 1930. Brick, slabs, pipes, etc., are formed of a mixture of lime sludge, produced in the manufacture of soda and clay, shale, marl, or slate, mixed in specified proportions and fired in a closed kiln to specified temperatures. The formed articles are dried in a closed kiln or chamber before the actual firing operation. In examples (1) a mixture of 1000 parts of clay of high plasticity containing organic matter and 250 parts of lime sludge is formed into brick, etc., which are fired at between 1500° and 1700°F; the products are of a cream color; (2) light-weight porous articles of a yellow color are produced by firing at 1600 to 1800°F a mixture of 100 parts of marl of low plasticity and 200 parts of lime sludge; (3) vitreous, nonporous articles of such colors as gold, bronze, and green are formed by firing between 1700 to 2000°F a mixture of 100 parts of shale containing carbon and ferric compounds and 100 parts of lime sludge. See also Brit. 12597/08.

Ceramic products. RENÉ LAHAUSSOIS. Fr. 675,214, May 15, 1929. Porous ceramic products produced from grains of fuel mixed with a plastic substance are made in two operations, the first consisting in baking the ceramic material in a reducing atmosphere without volatilization or burning of the fuel, and the second a baking at a relatively low temperature in an oxidizing atmosphere with complete burning of the fuel. (*C.A.*)

Refractories

New insulating product. ANON. *Brick. Clay Rec.*, **76** [10], 658 (1930); *Amer. Glass Rev.*, **49** [33], 14 (1930).—"Carey Aluminite" is a commercial high-temperature heat-insulating material derived from bauxite. The new Aluminite insulation is designed for use in connection with electric furnaces, firebrick boiler settings, heat-treating furnaces, glass furnaces, regenerator chambers in iron, steel, and other industries, and similar structures where internal temperatures range from 1800 to 2600°F. The commercial value of the new Aluminite insulation lies in its ability to resist the disintegrating effect of very high temperatures in addition to which it has such excellent heat insulating value that only one-half to one-third as much is required to give the same results now obtained from present commercial high-temperature heat insulating materials. E.J.V.

Silica and silica brick. ALFRED STEPHENS. *Corville's Mag.; Refrac. Jour.*, **5** [56], 280–82 (1930).—S. discusses properties and occurrence of silica and silicon. The first silica brick were made in South Wales about one hundred years ago, at a place called Dinas. Owing to the cutting nature of the material no satisfactory machinery for molding silica brick has yet been made. During crushing and grinding the material has to be kept moist to prevent dust getting into the atmosphere. Brick have to be fired at such a temperature that there is little or no after-expansion when they are heated in the furnace. The only expansion that then takes place is the thermal expansion which is complete at about 600°C. Kilns take from 6 to 12 days to fire, and the temperature is continually raised during the whole period. Afterwards, at least an equal time is taken to cool. Kilns for firing silica brick vary in size from a capacity of 20,000 to over 100,000. Raw material used for the manufacture of silica brick usually contains fully 98% silica. Silica brick are of importance in glass, copper, and gas works, and for construction of coke ovens. E.P.R.

Development of zonal structure in silica brick. A. E. BADGER. *Fuels and Fur.*, **7** [9], 1384 (1929).—A silica brick from the crown of a glass tank, which had been operated at 2450°F for seven years, was found to have a banded structure. The iron had migrated from the hot end toward the center of the brick and the iron near the cold

end had evidently changed form, causing light color changes through the length of the brick. A graph is shown. W.W.M.

Progress in testing refractories. ANON. *Fuels and Fur.*, **7** [7], 1077–78 (1929).—Reports at the A.S.T.M. meeting, June, 1929, include a revision of the heating rate of the standard method of test for softening point of fireclay brick, reports covering high-temperature cements, research work on service spalling test, the reheating test, and a note on the abrasion test for silica brick. W.W.M.

Investigation on the one-component system SiO_2. II. Catalysts for slow transformations. C. J. VAN NIEUWENBURG AND C. N. J. DE NOOIJER. *Rec. trav. chim.*, **47,** 627 (1928).—The correctness of Fenner's stability diagram for the three solid SiO_2 modifications (*Amer. Jour. Sci.*, **36,** 331 (1913)) was still doubted in some circles, chiefly because of his use of a large excess of catalyst. The catalytic effect of a great number of substances was investigated by heating pure quartz sand with 1% of catalyst at 1300° for 1 hour and then determining the percentage inversion. Lithium carbonate and, to a lesser degree, also sodium and potassium carbonates and sodium silico-fluoride were exceedingly effective and their use in silica brick manufacture was suggested. Other products which have been in use or advocated as suitable (sodium tungstate, boric and phosphoric oxides, etc.), proved to be only mediocre or even very poor ones. As a rule the addition of more than 1% of catalyst had scarcely any extra effect at all. For Part III see *Ceram. Abs.*, **8** [8], 605 (1929). (*J.S.G.T.*)

Examination of refractory brick. J. G. DE VOOGD. *Het Gas*, **50,** 15–22 (1930).—A lecture reviewing the physical and chemical properties of fire brick and silica and methods of determining them. Several photomicrographs of silica brick in sections are reproduced. (*C.A.*)

Plastic chromite cement. ANON. *Chem. Met. Eng.*, **37** [5], 316 (1930).—A new high-temperature product is marketed under the name of Adachrome Plastic Supercement by the Botfield Refractories Co. It is recommended for laying up fireclay, silica, chrome, and high alumina brick. It is used under certain conditions with magnesite brick. This cement is credited with high resistance to basic and acid slags, molten metal penetration, abrasion, and erosion. It is marketed in drums of 250 lbs. and 500 lbs. capacity. G.R.S.

High-temperature cements. FRED A. HARVEY. *Fuels and Fur.*, **7** [9], 1401–1407 (1929).—H. discusses the properties of refractory cements, which are (1) refractoriness, (2) wide temperature bonding range, (3) low shrinkage, (4) expansion and contraction approximately the same as the brick, (5) strength under load at high temperature, (6) resistance to slag erosion, (7) resistance to gas and fume penetration, and (8) working qualities. He gives suggestions on the correct use of the material, including application of thin coatings on kiln walls and arches. W.W.M.

Manufacture of refractories. SCHULZ AND KANZ. *Mitt. Forsch. Inst. Dortmund*, pp. 23–63 (1930); *Refrac. Jour.*, **5** [56], 308 (1930).—The manufacture of chromite, bauxite, and silicon carbide refractories is described, and their properties compared. The relative suitability of the use of the various types of brick under particular conditions are given prominence. E.P.R.

General refractory survey. ANON. *Refrac. Jour.*, **5** [56], 283 (1930).—During 1929 there has been a general adoption of modern manufacturing methods; tunnel kiln for firing fireclay, silica, and chrome brick, and many labor-saving devices. Several new refractories have come into prominence recently, among which are unfired magnesite brick, mullite, sillimanite, and refractory shapes made from a mixture of chrome and diaspore. Diaspore refractories which have been subjected to an unusually high heat treatment are available commercially, and development work is being carried out on the manufacture of light-weight cyanite brick which combine

heat-insulating properties with high refractoriness. Progress has been made in the design of special refractory shapes for blast-furnace stoves and open-hearth regenerators. The new shapes are said to result in large gas savings. Considerable research on the failure of refractories in service is under way in various laboratories, and studies are also being made on various phases of manufacturing methods. E.P.R.

Terms used in the refractories industry. ANON. *Refrac. Jour.*, **5** [56], 279 (1930).—*Black hearts.* The formation of a black "heart" or core is a result of faulty firing and is apparent when the portion of an article or mass is discolored, usually near the center. *Efflorescence.* A form of scum which is characteristic of certain clays. *Grog.* This includes broken brick and tile and fired articles. The term comprises fired clay of any kind. *Tridymite.* Discovered in trachyte and other volcanic rocks in which it occurs in the form of hexagonal plates. It is chiefly of interest as one of the products obtained by heating quartz to a high temperature. Tridymite is preferable to cristobalite in silica brick. *Cristobalite.* The terms "tridymite" and "cristobalite" are closely associated. Cristobalite was discovered in similar rocks in which tridymite was first found. It is a rare mineral. It is chiefly of interest as one of the products obtained by heating quartz. Cristobalite has no definite zone of stability. *Seat earth.* This lies immediately beneath the coal seams. Other terms used are "underclays," "spavin," and "warrant." They vary greatly in composition from an aluminous clay to a siliceous rock (ganister) and are generally thought to be the old soils in which grew the plants which later formed the coal seams. E.P.R.

French bauxite industry. ANON. *Le Ciment*, **2**, 69–73; **3**, 120–23 (1930); *Tonind.-Ztg.*, **54** [30], 521 (1930).—A short review of the world deposits of bauxite is followed by a description of the French bauxite and its physical and chemical properties. There are four kinds in France: (1) red, (2) gray, (3) white, and silicic acid bauxite. The first is found in the departments of Var and Hérault which supply about 85% of the French production, and is of three kinds: (1) containing 57 to 60% alumina, 18 to 22% iron oxide, and 2 to 3% silicic acid, and used for production of alumina; (2) containing 55% alumina, 20 to 24% iron, and 4 to 8% silicic acid, and used for production of abrasives and as an addition to fused cement; (3) containing 25 to 35% iron, 40 to 50% alumina, and is used in metallurgy. There are two kinds of gray bauxite: (1) 62 to 65% alumina, 8 to 10% iron, and 8 to 12% silicic acid; (2) 57 to 58% alumina, 10 to 14% iron, and 8 to 15% silicic acid. It is used chiefly for the preparation of abrasives. White bauxite has a small iron content which sometimes amounts to less th n 1%. Another white bauxite contains 66 to 72% alumina, 2 to 3% iron, and 6 to 10% silicic acid, but is very rare. Three other kinds contain 57 to 62% alumina, 3 to 5% iron, and 15 to 20% silicic acid; 54 to 56% alumina, 4 to 6% iron, and 16 to 22% silicic acid; 50 to 54% alumina, 4 to 8% iron, and 16 to 23% silicic acid. These three kinds are used in production of refractory products and electrotechnical porcelain. The silicic acid bauxite takes its name from its great silicic acid content, amounting to 25 to 45%. It is not widely distributed and is used for the preparation of refractory products. Bauxite is obtained in four departments: Var, Hérault, Bouches du Rhône, and Ariège. The deposits of Var are the most important in Europe and are described in detail. The total production of the department of Var amounted in 1904 to 53,000 T., and since 1926, to more than 400,000 T. The deposits of other departments are not so large and are described. About twelve firms are working in this industry. A short review of the production, export, use in commerce, and purchasers is given. France itself uses 45 to 50% bauxite production. The export increased from 110,915 T. in 1907 to about 250,000 in 1928. It is exported mainly to Germany, England, and the U.S. The French bauxite deposits are estimated at a total of 60 million T. M.V.K.

Dry mixing and improving the quality of refractory products. ANON. *Corriere ceram.*, **11** [2], 81–85 (1930).—Preparing dry masses includes the following conditions: fine, homogeneous preliminary grinding of the dried raw product; thinning agent in corresponding proportion to the binding clay, and thoroughly and homogeneously mixed with it; perfect and equal distribution of the smallest possible quantity of moistening water (for dry-press fireclay brick 4 to 6%, paving block 5 to 8%; plastic refractory pastes should have the consistency of bread dough). Only since the manufacture of appropriate mixing machines which combine mixing and moistening in a single rational intensive process, has the dry-press method been made advantageous for ceramics. An open mixer, rotating slowly in counter-direction to the movement of the mechanism, and equipped with one or two grinding rollers, with the water added as a fine spray by atomizers, has been devised by Eirich G.m.b.H., of Hardheim.

M.V.K.

Contribution for the solution of the problem of the use of glass pots. ANON. *Glashütte*, **60** [2], 21–22 (1930).—Recommendation for the fine grinding and thorough mixing of the glass pots and other raw materials before melting. L.T.B.

Brick and slabs for open-annealing furnaces. ANON. *Brit. Clayworker*, **39** [457], 56–57 (1930).—Furnaces of the downdraft type and of the reverberatory hearth type are chiefly used for annealing, though for some purposes muffle furnaces are almost exclusively employed. The construction of open-annealing furnaces should be good, and whether lined or wholly built with fire brick, the joints must be both sound and thin. In all cases a small amount of air is drawn through the walls of the furnace, this being unavoidable, but there is no reason why there should be much entrance of air if the brickwork is sound. To save cost in construction it is usual to have a shell of ordinary brick set in mortar and the fire brick set in fire clay. In some furnaces fireclay slabs are used for lining, but it is doubtful if there is much advantage gained by this for in rebuilding there is considerable waste owing to the breaking of the slabs when in use for any length of time. Most open-annealing furnaces have provision made against expansion which causes the arches to drop. The use of plates and tie-rods avoids this disagreeable feature. The temperatures attained in open-annealing furnaces are seldom higher than 1200°C so that there should be no difficulty about the material not being sufficiently refractory. Defects occurring in such furnaces are almost invariably due to fuel, to careless management of the furnace, or to errors in design and construction. R.A.H.

Cupola linings. E. LONGDEN. *Refrac. Jour.*, **5** [56], 273–74 (1930).—An analysis of the cupola practice in different parts of the country reveals an enormous variation in the construction and life of cupola linings. The life of the lining depends on the amount of melted metal during any single blow, character of the metal melted, amount and quality of limestone, velocity of blast, and distribution. The cleaner and brighter the appearance of the tuyères, the better the melting and metal. The shape of the tuyère has an important bearing on the action of slag. Bridging commences immediately above the tuyère, where slag is chilled by the incoming cold air. When the bridging has increased, rapid corrosion of the lining takes place due to the fluxing action of slag which is held in contact with the lining aided by the bridge and the strength of the blast. Molten metal also lingers on the bridge and may find its way into the bosh by trickling down the lining through one or more holes kept open by the blast. The metal, when it takes such a route, increases the fluxing of the lining. With two or three rows of contracted tuyères better results are obtained and the life of the lining is prolonged due to admitting air at a number of points on the lining which allows hot zones down which slag falls into the bosh. Of recent years, L. has obtained excellent results from lining designed in the Poumay cupola. Monolithic or rammed linings are not

comparable in economy and life to the brick lining. The best form of lining is of brick made from a mixture of small and medium silica grains and fire clay well fired to give a hard strong structure. The cupola should be lined with a double row of brick about 5 in. thick and 9 by 9-in. vertical faces. This size of brick can be easily handled and yet reduces considerably the joint areas. Use the best plastic refractory for jointing the brick. It is L.'s opinion that fluxing at the brick joints is not altogether due to the lower refractoriness of the mortar but to the lack of bond between the jointing material and the brick when contracting or expanding. E.P.R.

Refractory materials. COLIN PRESSWOOD. *Metallurgia*, **1** [2], 81–82; [3], 127–28 (1930); *Stahl Eisen*, **50** [17], 559 (1930).—Their importance for the metallurgical industry and their manufacture. The following points on selecting raw material are discussed: its preparation, properties, laboratory tests, physical and Seger cone tests, influence of atmosphere, softening under pressure, expansion due to heat, and resistance to rubbing off are discussed. See also *Ceram. Abs.*, **9** [5], 357 (1930). M.V.K.

Improved interlocking arch tile. ANON. *Fuels and Fur.*, **7** [10], 1630–31 (1929).—The George P. Reintjes Co. has an improved interlocking arch tile applicable to varying spans. The arch has a rise of $^1/_4$ in. per foot, and expansion is cared for by the center blocks which rise with a hinge effect, thus eliminating spalling. The tile is one brick course long, one brick course wide, and three high. W.W.M.

New method of installing refractory lining in furnaces. ANON. *Fuels and Fur.*, **7** [7], 1101 (1929).—The Covell Corp. has developed refractory shapes provided with lugs to maintain openings between the brick, which are laid without use of any bonding material. The openings are then filled with refractory joint material with a compressed air cement gun. This method saves time and gives a stronger and more refractory furnace lining, applicable to any type of unit. W.W.M.

Chemical engineering and coke-oven design and practice. J. W. HINCHLEY. *Colliery Guardian*, **140** [3619], 1746–48 (1930).—After pointing out that the operation of a coke oven was a chemical engineering job, the question of design of coke ovens was taken up. A higher rate of operating was obtained with the use of silica refractories due to their ability to withstand higher temperatures, but it is suggested that silica brick is not the last word in coke-oven construction. The question of regeneration vs. recuperation was discussed. In connection with the general construction of the coke oven the use of aluminous cement is taken up. The subject of heat flow is touched upon. E.J.V.

Rapid expansion in consumption of chromium. LEWIS A. SMITH. *Mining Ind. Rec.*, **33** [2], 21–22 (1930); for abstract see *Ceram. Abs.*, **9** [7], 573 (1930). E.J.V.

Wet-process manufacture of alumina. J. C. SEAILLES. *Compt. rend.*, **189**, 1276–79 (1929); *Giorn. chim. ind. applicata*, **12** [2], 104 (1930).—Attempt has been made to obtain alumina by the dry process using lime with bauxite; a clinker of $Al_2O_3 \cdot CaO$ is obtained; but the cost of firing at high temperatures and crushing this very hard clinker make this method impracticable for industry. A mixture, $Al_2O_3 \cdot 4CaO$, can be obtained if heated a short time in an autoclave (from 1.5 to 8 hrs. per 4 to 8 kg.), then treated with sodium carbonate, finally precipitating the aluminate obtained with a CO_2 current. Tests made under 200 kg. pressure gave the same results. The alumina obtained thus is free from iron, and contains 0.45 to 3.0% silica (which S. was able to reduce to 0.15%). This small quantity of silica is unimportant if the alumina is to be used for manufacture of silica compounds. See also *Ceram. Abs.*, **8** [12], 899 (1929). M.V.K.

Kuznetzoff-Zhukovsky alumina process. ROBERT J. ANDERSON. *Mining Jour.*, **169** [4941], 350 (1930).—The chief thermal smelting processes in use at the present time for the manufacture of alumina include the Hall, Haglund, and Penderson methods.

The first mentioned is direct, the others indirect processes. A good description of the three above methods and the Kuznetzoff-Zhukovsky process is given. The reactions for the latter are Al_2O_3 (bauxite) $BaCO_3 + Fe + C = BaO{\cdot}Al_2O_3 + FeSi + CO$. $BaO{\cdot}Al_2O_3 + Na_2CO_3 + H_2O = NaAlO_2 + H_2O + BaCO_3$. $NaAlO_2 + 2H_2O + CO_2 = Al(OH)_3 + CO_2 + NaOH$. Data are lacking as to comparative costs of production. E.C.C.

Rotary furnace for extraction of aluminium salts from clay. L. WASILEWSKI AND J. Z. ZALESKI. *Przemysl Chem.*, **14**, 181–88 (1930).—A rotary furnace for the continuous preparation by a modification of Rinman's method is described. A mixture consisting of 4 parts of ammonium sulphate to 1 part of alumina present in the clay is passed through a furnace, the distal three-fourths of which is maintained at 400°; where the time of passage of the reacting mass is 30 hrs., 88% yields of alum are obtained, with only very small losses of ammonia. Higher temperatures cause decomposition of ammonium sulphate, but it is probable that prolongation of the duration of reaction would give practically theoretical yields. The emerging product (at about 95°) is at once placed in water, in which the alum dissolves, leaving a residue of silica, suitable for the preparation of water glass. The extract, on keeping, deposits fairly pure alum, the iron content of which is, after one recrystallization, 0.002% FeO; this degree of purity suffices for the preparation of pure aluminium. (*B.C.A.*)

Protection of walls in firing chambers. JULES DESCHAMPS. *Feuerungstechnik*, **18** [9–10], 90–91 (1930); see *Ceram. Abs.*, **9** [3], 225 (1930). M.V.K.

Papers read at the Society of Glass Technology. ANON. *Chem. and Ind.*, **49** [16], 326 (1930); for abstracts see *Bull. Amer. Ceram. Soc.*, **9** [6], 209 (1930). G.R.S.

New use for old refractory material. D. A. MOULTON. *Clay-Worker*, **93** [6], 413 (1930); for abstract see *Ceram. Abs.*, **8** [7], 505 (1929). E.J.V.

Thermal expansion of silica brick and mortars. SANDFORD S. COLE. *Jour. Amer. Ceram. Soc.*, **13** [7], 437–46 (1930); for abstract see *Ceram. Abs.*, **9** [3], 190 (1930).

Influence of admixed oxides on the physical properties of silica brick. K. ENDELL AND R. HARR. *Stahl Eisen; Fuels and Fur.*, **7** [9], 1370 (1929); see *Ceram. Abs.*, **8** [10], 740 (1929). W.W.M.

Progress report on an abrasion test for refractories at high temperatures. JOSEPH B. SHAW, GEORGE J. BAIR, AND MYRIL C. SHAW. *Jour. Amer. Ceram. Soc.*, **13** [7], 427–36 (1930); for abstract see *Ceram. Abs.*, **9** [3], 191 (1930).

Slagging test for refractories. R. K. HURSH. *Fuels and Fur.*, **7** [8], 1219–20 (1929); see *Ceram. Abs.*, **8** [12], 887 (1929). W.W.M.

Properties of the fineness fractions of slaked semiflint clay. M. E. HOLMES AND A. J. PAUL. *Jour. Amer. Ceram. Soc.*, **13** [7], 447–53 (1930); for abstract see *Ceram. Abs.*, **9** [3], 193 (1930).

Study of fire clays. ANON. Bur. Stand., *Tech. News Bull.*, No. 156, p. 35 (1930).—A summary of the results obtained in the Bureau's report entitled "Some Fundamental Properties of Fire Clays at Several Temperatures." See *Ceram. Abs.*, **9** [3], 190 (1930). R.A.H.

Analysis of refractory materials. H. J. VAN ROYEN. *Fuels and Fur.*, **7** [10], 1600 (1929); see *Ceram. Abs.*, **9** [3], 230 (1930). W.W.M.

Refractory materials. DUNN. Indiana Govt. Pub. (1930); *Refrac. Jour.*, **5** [56], 308 (1930); for abstract see *Ceram. Abs.*, **9** [3], 201 (1930). E.P.R.

Refractory brick exudations. SIMON AND VETTER. *Refrac. Jour.*, **5** [56], 308 (1930); for abstract see *Ceram. Abs.*, **9** [6], 427 (1930). E.P.R.

Refractory brick. A. JAESCHKE. *Refrac. Jour.*, **5** [56], 292–301; 308 (1930); for abstract see *Ceram. Abs.*, **9** [7], 537 (1930). E.P.R.

Some industrial tests on refractory materials. W. H. SIMMONS. *Ceram. Age*, **14** [4], 139–42 (1929); see *Ceram. Abs.*, **8** [12], 890 (1929). W.W.M.

BOOKS

Knowledge of Ceramic Properties of Lime-Alumina-Silicates and Other Refractory and High-Refractory Materials. (Zur Kenntnis keramischen Eigenschaften von Kalk-Tonerde-Silikaten und anderen feuerfesten und hochfeuerfesten Materialen.) E. BERL AND FRITZ LÖBLEIN. VDI ed., Berlin, 1930, 28 pp., 15 illustrations. Reviewed in *Stahl Eisen*, **50** [17], 559 (1930); for abstract see *Ceram. Abs.*, **9** [7], 540 (1930). M.V.K.

Refractory Products. (Les produits refractaires.) ROBERT LEDUC. 320 pp., 185 figs., 25 plates. Published by Beranger, Li`ge, Belgium. Price, 123 Belgian F. Reviewed in *Rev. belge ind. verrières*, **1**, 67 (1930); for abstract see *Ceram. Abs.*, **9** [6], 439 (1930). A.J.M.

PATENTS

Refractory arch construction. BRADLEY DOBIE. U. S. 1,760,121, May 27, 1930. A refractory arch construction comprising spaced runners, and brick with unequal shoulders resting on the runners removable after lateral displacement in the direction of the wide shoulders.

Refractory product. HAROLD C. HARRISON. U. S. 1,760,133, May 27, 1930. The method of producing a refractory ceramic product which comprises first preparing a raw batch containing more than 50% by weight of a mineral belonging to the cyanite group and subsequently dry pressing the batch into the desired shape and firing the dry-pressed article thus obtained.

Treating clay. WINFRED G. BUCKLES. U. S. 1,760,191, May 27, 1930. The herein-described method of making a high refractory formed, in the main, of a crystalline material and a clay, which consists of storing the clay in finely-divided form in that quantity of water necessary for the reduction to moldable condition of the whole mass for a period of time sufficient to permit microscopic penetration of the clay by the water, the quantity of water being sufficient to produce a flowable cream, and thereafter pugging the cream and the crystalline material together.

Skewback block. JOSEPH BROOKES. U. S. 1,760,296, May 27, 1930. A skewback support of substantially rectangular cross-section having a face thereof of step formation to constitute a shoulder, the shoulder being normal to the body portion and intermediate the top and bottom edges of the body portion, the face being continuous from the shoulder to the lower extremity of the support.

Refractory product. HARRISON P. HOOD. U. S. 1,760,360, May 27, 1930. A batch for a refractory product containing a crystalline aluminium silicate and a binder containing aluminium hydroxide and silicic acid.

Preparation of zirconium. WILLIAM PHILIP KIERNAN. U. S. 1,760,413, May 27, 1930. The process of producing formed articles of zirconium which comprises producing a relatively pure coarse metal powder of the metal, compacting the powder, heating the compacted article to a low temperature in a high vacuo to substantially degasify the compacted metal powder, sintering the degasified article at a high temperature approximating, but below, the fusion point thereof in the same high vacuo and thereafter subjecting the sintered article to mechanical deformation at temperatures approximating 800°C.

Side brick for firebox arches. JOHN E. MUHLFELD. U. S. 1,760,431, May 27, 1930. A side brick for firebox arches having a seat formed on one end to engage an arch tube and formed at its other end with surfaces curved transversely in opposite directions from the center line of the brick, the end surfaces being also rounded or con-

vex longitudinally of the brick and presenting spaced points of contact with the side wall of the firebox when the brick is arranged in an upwardly inclined position between the side sheet and the arch tube.

Making refractory blocks. GEORGE W. PARKER. U. S. 1,760,861, May 27, 1930. The method of making refractory blocks which consists in hand kneading a wauk of refractory clay, separating a portion of the wauk from the remainder thereof and then giving to the separated portion the desired shape in such a manner that the grain formed therein during the kneading will extend at right angles to the wearing face of the block.

Furnace wall. HOWARD J. KERR. U. S. 1,761,567, June 3, 1930. A furnace wall having a row of spaced tubes, connections to supply a cooling medium to the tubes, tile between each pair of adjacent tubes and having recesses for the tubes with the sides of the recesses toward the inner faces of the tile substantially closed, and a metallic lining covering the outer face of the wall, the lining comprising a plurality of plates, each contacting with at least one of the tubes.

Replaceable wall structure for furnaces. DANIEL E. SULLIVAN. U. S. 1,763,606, June 10, 1930. A wall structure for furnaces, etc., having an inner wall formed from a heat-resisting refractory material, removable and sectional pre-formed panels of heat-insulating material applied directly to the outer surface of the inner refractory wall, a plurality of weatherproof sheets applied to the outer surface of the panels, a plurality of metallic strips arranged to cover the meeting edges between the panels and sheets, and removable threaded devices connecting the strips for drawing the strips into clamping engagement with the sheets and panels.

Furnace wall. W. EHMANN. Brit. 327,641, June 5, 1930. In a furnace wall consisting of an outer wall spaced from a refractory lining wall, the lining wall is made up of separately removable sections each in the form of an arch. The superposed sections of the lining wall are carried by brackets projecting from the outer wall into the plane of the lining wall, and shielded from the fire by the upper part of the section below. The arches are supported laterally by wedge-shaped blocks which are threaded onto and held in place by iron bars of T-shaped cross-section, secured to the outer wall by anchor bolts. Springs bring the sections back to their previous position on cooling. In the upper part, where smaller expansions occur, refractory brick project inward from the outer wall to prevent the sections becoming loose.

Alumina. ELEKTRIZITÄTSWERK LONZA. Swiss 134,933, Aug. 4, 1927. In the preparation of Al_2O_3 from aluminiferous material, *e.g.*, bauxite, by heating with a reducing agent in an electric furnace, finely divided magnetic metal such as Fe or Fe alloys is added. The metallic alloy separating from the Al_2O_3 can then be removed magnetically. (*C.A.*)

Electric resistance material. CARBORUNDUM CO. Brit. 319,647, Nov. 20, 1929. Nonmetallic resistance rods such as those formed of SiC or graphite are provided with a protective coating which glazes between 1150° and 1750° and is formed of a mixture of oxides or of one or more oxides and halides substantially free from silica; or, protective material comprising at least 70% Al_2O_3 with Ti oxide or alkaline earth halides is mixed with the material of which the rod is formed. (*C.A.*)

Glass furnaces employed in conjunction with glass-blowing machine. BULLMAN MACHINE CO., LTD. Fr. 674,529, 674,530, and 674,531, May 3, 1929. (*C.A.*)

Alumina. PAUL L. J. MIGUET AND MARCEL P. PERRON. Fr. 675,084, Sept. 29, 1928. Artificial bauxite suitable for the manufacture of pure Al_2O_3 is prepared by a regulated reduction in an electric furnace of substances not suitable for the direct preparation of Al_2O_3, such as ashes, kaolins, and clays. An Fe-Si containing little Al is produced as a by-product. (*C.A.*)

Silico-aluminum. EDOUARD URBAIN. Fr. 675,143, Oct. 10, 1928. A Si-Al alloy

rich in Si and Al is obtained by heating silico-aluminates mixed with a reducing agent to quiet fusion and distillation of K. The K is separated from the fumes and recovered, either as a silicate or other salt. (*C.A.*)

Refractory materials. HANS HAGEMANN. Fr. 676,398, June 8, 1929. Refractory stones which will withstand a temperature of 1800° are made from quartzite using liquid carbides and silicides as agglomerating agents, and with the addition of metallic oxides and about 4% CaO. (*C.A.*)

Terra Cotta

Reactivity test for determining the value of barium carbonate as a scum preventative. A. LEE BENNETT AND H. R. GOODRICH. *Jour. Amer. Ceram. Soc.*, **13** [7], 461–69 (1930); for abstract see *Ceram. Abs.*, **9** [3], 204 (1930).

Rationalization in the chemical factory. New results on stoneware standardization by the Dechema committee for standardization of acidproof stoneware. F. PLINKE. *Chem. Fabr.*, pp. 122–26 (1930).—Cuts and dimensions are given for armored cocks, stationary and railway portable flasks, towers, perforated plates, reducers, laboratory jars, etc. See also *Ceram. Abs.*, **8** [11], 826 (1929). (*C.A.*)

White Wares

Testing glazes. ANON. *Ceram. Age*, **14** [5], 79–84 (1929).—A digest on the subject of glaze testing, particularly for crazing and hardness. Examples of tests which have been made, results obtained, and deductions to be considered are given. W.W.M.

Simple method for comparing sub-sieve particle distribution in nonplastics. M. H. HUNT. *Jour. Amer. Ceram. Soc.*, **13** [7], 454–57 (1930); for abstract see *Ceram. Abs.*, **9** [3], 207 (1930).

Practical method of controlling the quartz content of feldspar. JOSEPH B. SHAW. *Jour. Amer. Ceram. Soc.*, **13** [7], 470–74 (1930); for abstract see *Ceram. Abs.*, **9** [3], 206 (1930).

Electrical porcelain. R. K. GRANTHAM. *Ceram. Age*, **14** [1], 6–12 (1929).—A treatise on electrical porcelain, prepared as a thesis at the Mo. School of Mines and Metallurgy. G. discusses wet and dry manufacturing processes, preparation of bodies, mechanical tests, resistance and actual service characteristics, problems of design, etc. W.W.M.

Manufacture of electrical insulators. ANON. *Colliery Guardian*, **140** [3620], 1850–51 (1930).—The new works of Steatite and Porcelain Products, Ltd., of Stourport, Worcestershire, England is described. The principal raw materials for the manufacture of high-tension porcelain are china clay, plastic kaolin (ball clay), quartz, and feldspar. Kneading machines are used to eliminate entrapped air from the body prior to the formation of the insulators. After drying, the high-tension insulators are glazed on a glazing machine with a highly refractory feldspathic glaze, the exact composition of which and its expansion relative to the body have an important bearing on the ultimate mechanical strength of the insulator. The firing is done in saggers in a tunnel kiln. The equipment of the high-tension testing laboratory and the tests made are described. Illustrated. E.J.V.

New art glaze ware. ANON. *Clay-Worker*, **93** [5], 351 (1930).—The Homer Laughlin China Co., Newell, W. Va., has introduced a new art glaze ware, which is being produced in French rose, sienna brown, and leaf green shades. The ware, opaque and

made in the Wells pattern, is produced in the complete dinner, luncheon, breakfast, tea, and waffle sets and in open stock, and is made exclusively at the No. 7 plant with an ivory body. E.J.V.

Modern Swedish pottery. ANON. *Sprechsaal*, **63** [17], 302–304 (1930).—Modern Swedish pottery is described. The article is illustrated. M.V.K.

PATENTS

Transformer container. ALPHONSE F. PIEPER. U. S. 1,759,997, May 27, 1930. In an oil-tight mounting for a high-tension bushing of an X-ray oil transformer, etc., in combination, a bushing, a cover having an opening therethrough for reception of a portion of the bushing, the cover also being provided with a recess in its upper face extending about and from the opening, a compressible sealing gasket fitting into the recess and of a normal thickness greater than the depth of the recess, the bushing being provided with a threaded portion extending through the opening and corresponding in cross-section thereto, the bushing being also provided with a shoulder at the upper face of the cover and extending outwardly beyond the recess and the gasket therein, and a nut screwed onto the threaded portion of the bushing and bearing against the under face of the cover, the under face of the shoulder seating flat upon the upper face of the cover outwardly beyond the gasket, the cover being clamped between the nut and the shoulder and the gasket being compressed axially and expanded radially by the shoulder into sealing contact with and about the portion of the bushing, the under face of the shoulder being in sealing contact with the upper face of the gasket.

Spark plug. PHILIP K. DEVERS. U. S. 1,760,586, May 27, 1930. A spark plug comprising a hollow silica body, a conductor passing through the bore thereof, a relatively thin coat of metal on substantially the entire outer surface of the hollow body and a relatively heavy metal shell alloyed with the thin coating, and spark points mounted on the conductor and shell.

Manufacturing wire and porcelain elements. FREDERICK S. MCCULLOUGH. U. S. 1,761,577, June 3, 1930. A method of making refractory bodies with wires therethrough which consists in forming a length of refractory rod with a hole therethrough, allowing the refractory material to set, then passing a wire through the hole, and firing the refractory rod with the wire therein under conditions which preclude oxidation of the wire.

Manufacture of pottery or ceramic articles. JOSEF DENGLER. U. S. 1,762,387, June 10, 1930. A machine for making ceramic ware comprising a revolvable table, means for intermittently revolving the table, molds carried by the table, means for axially revolving the molds, a standard situated adjacent the table, a bracket connecting the standard with the table, levers rockably supported by the bracket, means for rocking the levers, a device for wiping plastic substance at the end of one of the levers, a shaping template at the end of the other lever, a spraying device adjacent the template, a pneumatic shock-absorbing and movement-regulating device coöperating with the wiper-carrying lever, a two-armed rockable pawl coöperating with the wiper-carrying lever, stationary trip pin also coöperating with the pawl, an edge-trimming cutter coöperating with the wiper-carrying lever and molds, a water supply pump, a plastic substance supplying press, means situated about the orifice of the press for forming the plastic substance into sheet formation, means for smoothing the sheet of plastic substance and means for cutting off the sheets, and mechanism, operated by the mold supporting table, for intermittently operating the rotary sheet-forming tool.

Insulator string. JOSEPH SLEPIAN. U. S. 1,763,196, June 10, 1930. (1) A device including electrical elements in series and a resistor element shunted across the entire series of electrical elements and in electrical connection, at intermediate points, with the respective intermediate terminal members of the several electrical elements, the resis-

tance of the resistor element under normal voltage conditions being of the same order of magnitude as the resistance of the series of electrical elements, and one or more sections of the resistor element have the further property, when a predetermined critical excessive voltage is exceeded, of passing current discharges with comparative freedom and of returning to its normal high-resistance state when normal voltage conditions are restored. (2) An insulator unit having conducting terminal parts separated by an insulating member, the insulating member being provided with a perforation extending therethrough from one conductor terminal to the other, and a protective device located in the perforation and having its terminals connected to the terminals of the insulator unit, the protective device comprising a stack of plates including plates having a resistivity of at least several thousand ohms per centimeter cube.

Ceramic tile-mounting machine. LAWRENCE N. YINGER. U. S. 1,763,494, June 10, 1930. An apparatus of the class described comprising a supporting frame, a pair of drums rotatably arranged therein, one drum being arranged at a higher level than the other, an endless belt passing over the drums and having tile-receiving recesses therein, chutes for feeding the tile into the recesses just before the belt passes from the lower drum, means for supporting a rolled strip of paper on the frame, a reservoir containing adhesive on the frame, a roll supported on the frame and extending into the reservoir and over which the strip extends, a presser roll on the frame for pressing the strip after it leaves the adhesive roller onto the tile, a second endless belt, rollers for the belt, means for directing the strip with the tile thereon from the first belt onto the second belt and means for heating the strip and tile as it travels along with the second belt.

Teapots, etc. W. COULTER AND H. F. WOOD. Brit. 327,579, May 28, 1930. Longitudinal half-sections of a teapot, etc., adapted subsequently to be united in pairs to form a complete article, are formed between dies comprising a three-part intaglio die associated with a rigid cameo die. The intaglio die comprises a central body section furnished with spout and handle portions embraced by outer sections forming the base and mouth portions. The parts are connected by dovetails and the section is recessed to accommodate a plunger which is advanced to form the base flange. A loose oval member forms the handle aperture. The cameo die comprises a plate carrying rigid body and spout dies. Three or more pins, spikes, etc., are mounted in the body and are advanced, during molding, to pierce the web between body and spout. The central section is moved vertically to deliver the formed article. The two halves of the article are preferably assembled as described in the following patent. See also Brit. 320,519.

Teapots, etc. W. COULTER AND H. F. WOOD. Brit. 327,580, May 28, 1930. Teapots, etc., are formed by bringing together molded halves of the article within complementary dies which are reciprocated relatively to one another to knead together the adjacent edges. The halves of the article are supported respectively in a lower die carried by a slide reciprocated by an eccentric, and an upper die balanced by a weight attached to a cord and adapted to be lowered in proximity to the die by a hand-wheel. Stops limit the descent of the die to avoid undue pressure. In operation, the molded halves, preferably made as described in the preceding patent, are inserted into the dies and the edges smeared with slip; the die is lowered and the slide reciprocates to weld the edges. After this operation the eccentric is disconnected through a hand lever controlling a double clutch and the dies are centered by a tapered pin recessed to engage a corresponding notch in the slide through a hand lever and link. The hand lever also actuates through bevel gear a tool to finish the spout. The mouth is trimmed by a rotary tool which is rotated through a drive and the clutch. A lever actuated from the spout tool through a compression spring advances the tool.

Ceramic products. LA PORCELAINERIE DE LESQUIN. Fr. 673,940, April 24, 1929. Ceramic products, particularly porcelains for electric insulators, and composed generally

of clay, SiO_2, and feldspar, are made by incorporating in the porcelain or substituting for part or all of the feldspar, lepidolite, *i.e.*, a mica composed of silicates of K, Li, and Al, and small quantities of salts of F, Fe, Mn, Ca, Mg, Na, Rb, Cs, and a little water. (*C.A.*)

Electric insulators. FELIX SINGER. Ger. 493,001, Nov. 14, 1925. Electric insulators are prepared from stoneware to which a Ti compound or compounds have been added, and which have been fired under such conditions that more than one Ti compound is present in the final product. The presence of a number of Ti compounds increases the dielectric strength. (*C.A.*)

Ceramic materials. A C SPARK PLUG CO. Fr. 675,384, May 18, 1929. Ceramic materials are made by fusing a raw mass containing, *e.g.*, Al_2O_3 60, Li_2O or Li_2CO_3 at least 5, and clay at most 35%, or Al_2O_3 90, Li_2O_3, and clay 5%. The molten mass is cooled rapidly to produce small crystals and the product obtained is mixed with clay, from which mixture the objects to be made are molded and baked. See also *Ceram. Abs.*, **8** [11], 822 (1929). (*C.A.*)

Equipment and Apparatus

Selection of pyrometer wire. ANON. *Brit. Clayworker*, **39** [457], 57 (1930).—It is necessary to select wire used in an electric pyrometer very carefully or the maintenance of the instrument may be costly. Platinum and its alloys absorb gases readily at high temperatures and are easily spoiled; they also undergo changes at the hot junction of the two wires, causing errors in temperature readings. No substance is known which provides a really satisfactory protection to the wires; hard porcelain is better than fire clay, but neither is durable at high temperatures. A platinum or noble metal couple which can be used for 3 months and yet retain its accuracy is seldom found. The gradual poisoning of the wires by impurities in the kiln gases soon makes the wires useless. The remedy for this consists in (1) using a pair of base metals which are less sensitive to kiln gases; (2) employing a radiation pyrometer for temperatures above that at which a base metal couple can be used; (3) using Seger cones or Holdcroft thermoscopes. Among the base metals, nickel and alloys of nickel and chromium are usually the most suitable, but couples made of nickel and graphite have also been used satisfactorily. The comparative cheapness of base metal couples is a further factor in their favor. R.A.H.

Temperature measurements without pyrometers. EDMUND R. THEWS. *Can. Chem. Met.*, **14** [4], 111–15 (1930).—While the use of pyrometers is becoming greater and greater in the industrial field there are still quite a few good old, simple methods which can be used for measuring temperatures without pyrometers and still be fairly accurate, at least enough so for all practical purposes. Some of these simple methods are enumerated and discussed. E.J.V.

Vacuum tube potentiometer for determination of true e.m.f. of a high-resistance cell. R. J. FOSBINDER. *Jour. Phys. Chem.*, **34** [6], 1294–1302 (1930).—This paper describes a single-tube direct-current amplifier whose chief attributes are simplicity, stability, high sensitivity, and ease of control. The theory and construction of the vacuum tube potentiometer are described in detail. By operating the amplifier under well-defined conditions, an accuracy of $\pm$ 0.0001 V can be obtained. G.R.S.

Calorimetry in furnaces. W. P. WHITE. *Jour. Phys. Chem.*, **34** [6], 1121–36 (1930).—A discussion is given of calorimetry performance within furnaces, with a report of various experiments. As to precision, it seems promising for some latent heat determinations, much less so for specific heat. In no case does the precision seem likely to be better than one per cent. G.R.S.

Automatic thermoregulator. J. A. BEATTIE AND D. D. JACOBUS. *Jour. Phys. Chem.*, **34** [6], 1254–59 (1930).—A flat type of platinum resistance thermocouple is placed in the bath to be regulated and its resistance balanced on a wheatstone bridge which is connected to a galvanometer in the usual manner. A beam of light is reflected from the galvanometer mirror onto one of two photoelectric cells whose change in resistance varies the grid potential of a three-electrode vacuum tube sufficiently to operate a sensitive relay, which in turn operates the relay that controls the regulating current in the bath heaters. The temperature of a stirred liquid bath has been maintained at any desired value from room temperature to 450°C with a variation of ± 0.001°C. The method can also be used to regulate the temperature of air baths. G.R.S.

Improved Orsats. ANON. *Chem. Met. Eng.*, **37** [5], 316 (1930).—A new and improved line of gas analyzers is being marketed by the Hays Corp., Ind. This is being built in six standard ranges available in lightweight, metal carrying cases weighing only 8 lbs. complete. Three additional special ranges are available in slightly larger cases. These instruments are similar in principle to the usual Orsat analyzer. They feature quick operation and extreme lightness. The chemical bottles for absorbing CO_2, CO, and O_2 are of molded hard rubber filled with steel wool, said to permit complete analysis in 4 to 5 minutes. Monel metal needle valves replace the usual glass stop-cocks and pinch clamps. The method of mounting the few glass parts is said to result in practical elimination of the danger of breakage. G.R.S.

Improved method of installing CO_2 meters. ANON. *Fuels and Fur.*, **7** [8], 1244 (1929).—An improved CO_2 meter installation, developed by the Brown Instrument Co., is described. Its operation is based on the comparative thermal conductivities of air and the gas being analyzed. W.W.M.

A rotation viscometer. J. H. SHAXBY. Proc. Physiol. Soc. *Jour. Physiol.*, **68,** xiii (1930).—A brass cylinder is suspended with its axis vertical by a fine wire and hangs immersed in the liquid whose viscosity is to be measured. The vessel containing the liquid stands on a table, which is slowly rotated by a pulley. The twist set up in the wire by the viscous forces is indicated by a mirror attached to the cylinder, and a lamp and scale. (*C.A.*)

Universal luminoscope (fluoroscope, phosphoroscope) and nephoscope. STJEPAN MOHOROVIČIC. *Arhiv za Hemiju i Farmaciju*, **4** [2], 73–76 (1930).—A new apparatus which can be used as a fluoroscope, a phosphoroscope, a nephoscope, a projection apparatus, and a photometer is described and each use is explained. E.J.V.

Unique instrument for measuring contours. ANON. *Glass Ind.*, **11** [6], 141 (1930).—The Maco template will give an instant and visible result which is perfectly measurable. When an exact template of any profile is required, it is only necessary to loosen the screws and gently press the adjustable template against the contour. The result of such pressure is that the laminae take a perfect outline of the surface against which they are pressed, their extreme thinness materially assisting in the facility and precision of the process. When the pressure is complete, by locking the screws, the laminae are held in position. Set in an aluminum frame or housing, this template is composed of a number of very fine strips of hard-drawn brass, and is consequently rustless. The thickness of each strip is 0.007 in. These laminations are held in position by two special clamps which are fitted with sections of corrugated rubber that insure the security of the laminae from falling out. This device is already in use in prominent glassware factories and glass machinery builders' plants. Illustrated. E.J.V.

German developments in crushing and grinding. CARL NASKE. *Pit and Quarry*, **20** [4], 78–79 (1930); for abstract see *Ceram. Abs.*, **9** [3], 218 (1930). E.P.R.

Modern silica grinding pays big dividends. R. L. CAWOOD. *Chem. Met. Eng.*, **37** [5], 304–305 (1930).—Much has been accomplished in the last ten years to lower grinding

cost, and rapid strides are now being made in the development of apparatus and in the reconstruction of grinding plants. One example of what has been done is to be found in silica grinding. The cost has been cut almost in half and the quality of the product has been greatly improved. Only a few years ago this material was ground to a fineness of 97% through 140-mesh, but today 97% passes the 200-mesh, making grinding considerably more difficult. A detailed description is given of the new grinding unit of the Potters Mining and Milling Co., East Liverpool, Ohio. G.R.S.

Impact pulverizer. ANON. *Fuels and Fur.*, **7** [8], 1243–44 (1929).—An impact attrition pulverizer, developed by George F. Pettinos of Philadelphia, operates on ores, limestone, hydrated lime, coal, coke, etc. It takes pieces up to $1^1/_2$ inches in size and due to construction details acts as a separator, holding back all material until it has reached the desired fineness. W.W.M.

New developments in the field of pebble mill grinding. HENRY F. KLEINFELDT. *Ceram. Age*, **14** [6], 214–17(1929); see *Ceram. Abs.*, **8** [11], 830 (1929). W.W.M.

Pneumatic transport of granular and powdered materials. H. NEU. *Bull. Soc. Ing. Civ. France*, **82**, 987–1041(1930).—A pneumatic method of transporting materials requires a pressure difference of 100 to 450 mm. Hg and an air supply of 30 to 500 liters/kg. of material, according to circumstances. The calculation of an installation, which cannot be performed by theory alone, permits of two solutions, the minimum capacity and the most economical capacity. Various methods of feed and discharge are described together with types of pumps for the production of pressure or vacuum. Pneumatic transporters can deliver up to 300 T. per hr.; they are flexible and economical in labor, but they have a higher power consumption than other types. They are suitable for grain of all kinds, coal dust, cement, ammonium sulphate, etc. Portable transporters for discharging ships are described. Analyzed costs of five transporters handling coal and grain are given. This method of handling has the convenience of taking up little room, and the crossing of obstacles such as railway lines presents no difficulty. (*B.C.A.*)

Newest handler of finished products. ANON. *Brick Clay Rec.*, **76** [10], 658 (1930).—The Clark Brick Hacker, manufactured by the Clark Tructractor Co., Battle Creek, Mich., is equipped with a tilting platform fitted with seven prongs or "fingers." In operation the brick are stacked on blocks or brick in a hack containing 550 brick. The fingers are inserted beneath the hack and the platform with its load is tilted so that the brick may be transported without danger of falling off. Arriving at the storage or railroad car, the driver quickly arranges the supporting blocks and deposits his load. The advantage of this system becomes evident when it is realized that the labor of picking the brick up and setting them down is entirely eliminated except in the first instance of building the hack. Illustrated. E.J.V.

Mine transportation of limestone. RALPH W. SMITH. *Eng. Mining Jour.*, **129** [9], 462–64 (1930).—An illustrated description of good transportation methods. E.C.C.

Chain and loading equipment. ANON. *Chem. Met. Eng.*, **37** [5], 317 (1930).—Two new developments are announced by the Link-Belt Company. The first is a new form of steel drive-chain known as Hyper chain. This is made from alloy steel, heat treated, and makes use of a new type of pin and cotter. Parts are accurately ground, while cotters are of a special type which cannot work loose. The new chain is sold in two sizes having an ultimate strength of 75,000 lb. and 150,000 lb., respectively. A second development is a high-capacity crawler bucket loader, known as "Grizzly 1930 Model." It consists of a bucket elevator fed by means of a special digger, the whole mounted upon a motor-driven crawler. The digger is said to be self-sharpening and to convey material to the elevator in a smooth continuous stream. G.R.S.

Unbraced cables. J. FELD. *Jour. Frank. Inst.*, **209** [1], 83–105 (1930).—The usual methods of design for long span cables, either with or without concentrated load, are found to be inaccurate because they omit the elastic stretch of the cable and they assume an inaccurate shape of the resulting curve. Equations are derived to cover all possible cases, loaded and unloaded cable; and equations showing the variation in several quantities with changes in temperature and movement of supports. A discussion is given of conditions of possible loads and elastic properties of cables. A bibliography is included covering major references to the subject. M.A.B.

Experience with slurry filters at the Osborn, Ohio, plant of the Southwestern Portland Cement Co. EARL C. HARSH. *Rock Prod.*, **33** [11], 51–54 (1930).—An illustrated description of a slurry filter installation, using American continuous type Oliver filters, which remove 56% of the water from the kiln feed. The filter cake is mixed with the material from the dust-collecting system, by a pug mill which empties through a screw conveyer into the kiln. W.W.M.

Slurry having both abrasive and corrosive properties can be pumped efficiently. ANON. *Pit and Quarry*, **19** [3], 71–72 (1929). E.P.R.

Straining liquid pastes. ANON. *Corriere ceram.*, **11** [3], 115–21 (1930).—The new "Visco" (1928) vibrating sieve which is run by electricity and is more efficient and durable than other less modern types of sieves for straining liquids, viscous or thick slips is described. M.V.K.

Dust collection in foreign quarries. ANON. *Quarry Managers' Jour.* (British); *Rock Prod.*, **33** [12], 90–91 (1930).—Dust in quarries causes silicosis among the workman. Several types of dust collectors were tried and the best one, when installed, reduced the dust settling per square yard from 1.63 oz. to 0.003 oz. Other data are given. W.W.M.

The fluorometer: an apparatus for cements. G. BAIRE. *Chim. & Ind.* [Special No.] 472–73 (Feb., 1929); reviewed in *Pit and Quarry*, **18** [12], 112 (1930).—A brief description is given of the Mayntz-Petersen fluorometer, in which the fineness is determined by an air-elutriation test. Generally speaking, cement leaving a 12% residue on a sieve having 4900 meshes per sq. cm. will leave 38% residue in the fluorometer after blowing air for 15 minutes under a pressure of 6 cm. of turpentine; a cement leaving 2% residue on the same sieve will leave 25.4% residue in the fluorometer under the same conditions. The results can vary with the nature of the cement and of the grinding equipment. E.P.R.

Vibrating screen. ANON. *Chem. Met. Eng.*, **37** [5], 314–15 (1930).—Mechanically produced vibration, which is transmitted equally all over the entire screen body, is a feature of a new centrifugal vibrating screen produced by the Allis-Chalmers Mfg. Co. Vibration is produced by the eccentric suspension of the screen from a rotating shaft. Self-aligning, antifriction, roller-type bearings transmit the motion of the eccentric to the screen. This type of screen is made in various sizes, and is supplied with single or multiple decks. The screen surfaces are easily removed and replaced. The screening angle may be adjusted to suit different operating conditions. G.R.S.

Developments in sieving technique. ANON. *Metal Erz*, **27** [8], 209–15 (1930).—Recent developments in apparatus are described. L.T.B.

New type hydraulic press. ANON. *Brick Clay Rec.*, **76** [10], 659 (1930).—A new hydraulic power press recently put on the market by the Hydraulic Press Manufacturing Co., Columbus, Ohio, is said to be revolutionary in both design and operation. Heretofore, hydraulic presses have possessed two major disadvantages for production work, the necessity of installing considerable auxiliary equipment and slow speed of operation. The new press is designed to handle practically anything that its size and tonnage will accommodate, from short stroke to long stroke work. High-speed automatic action of the

press is achieved through the use of specially developed hydraulic-control mechanism. These controls may be set for either semi-automatic or full automatic operation. The cycle of operation is given. Illustrated. E.J.V.

Studies of machines for extruding clay columns. PAUL G. GRUNWELL. *Ceram. Age*, **14** [3], 88–97 (1929); see *Ceram. Abs.*, **8** [2], 113 (1929). W.W.M.

Two machines for the brick industry. A. PELLACINI. *Corriere ceram.*, **11** [2], 57 (1930).—Two new Italian models for the brick industry on the market are (1) a small machine for excavating and transporting clay (S.E.C. of Pracenza), and (2) a feeder and distributor (V. Busini and Co., Cremona), both of which will compete successfully with foreign makes in strength and precision of construction, in perfection of mechanical movement, and in their contribution to economic management. M.V.K.

Apparatus for cutting brick and similar products. P. RENAULT. *Rev. mat. constr. trav. pub.*, No. 246, pp. 53–56B; No. 247, pp. 73–75B (1930); see also *Ceram. Abs.*, **9** [7], 550 (1930). A.J.M.

Observations on drying brick. ANON. *Corriere ceram.*, **11** [2], 49–55 (1930).—The use of a hygrometer is important for obtaining maximum efficiency of a drying installation. The hydrometer indicates the content of water vapor of the air; it can be made easily by using two accurate thermometers. Directions are given for making and using this instrument. M.V.K.

Control of fabrication in the stoneware and tile industries. ANON. *Rev. mat. constr. trav. pub.*, No. 246, pp. 51–53B (1930). A.J.M.

Measurement and recording in the factory. ANON. *Chem. and Ind.*, Supp. No. 49*S*, 48, 1–32 (1929).—Sixty-six firms describe their various meters, and there is a classified index of the apparatus. H.H.S.

Individual motor drives. RICHARD L. CAWOOD. *Ceram. Ind.*, **14** [6], 644–45 (1930); for abstract see *Ceram. Abs.*, **9** [3], 217 (1930). W.W.M.

Electrical power in brickworks. ANON. *Brit. Clayworker*, **39** [457], 53–54 (1930).—The article discusses when it is advisable to replace obsolete equipment and the electrical tools it is desirable for a plant to have in order to make proper repairs on equipment. Such tools include portable tools for electrical welding, soldering, drilling, hammering, shearing, saws, etc. R.A.H.

Chrome plating. W. BIRETT. *Glas-Ind.*, **37** [14] 205–206 (1929).—Chrome plate, its use on glass molds, and details of the process used in chrome plating are discussed. The advantages of chrome plated molds are enumerated. Illustrated. See also *Ceram. Abs.*, **8** [10], 760 (1929). E.J.V.

Chromium-plated glass molds. C. J. STAHL. *Glas-Ind.*, **37** [13], 191–93 (1929).—The properties of chromium are discussed. Various different metals used for molds are enumerated and their qualities compared with chrome-plated iron molds. The details of chrome plating methods and technique are presented. E.J.V.

BULLETIN

Quarry plants. ANON. *Pit and Quarry*, **20** [4], 71 (1930).—The Smith Engineering Works, Milwaukee, has issued Bulletin, No. 267B with layouts of various types of crushing and screening plants, discussing advantages and objectionable features. E.P.R.

PATENTS

Air classifier. ALBERT H. STEBBINS. U. S. 1,759,959, May 27, 1930. An air classifier comprising a container having upstanding side walls disposed in spaced relation to form an air passage between them and provided with corrugations or flutes that extend downwardly diagonally of the path of the air through the passage at an acute angle to the direction of travel of the air stream, and means for advancing material-laden air

through the passage so that the heavier particles that work out of the path of the air into the channels between the corrugations or flutes will be carried by their velocity along the downwardly inclined channels toward the lower wall of the classifier.

Concentrator table. ALBERT H. STEBBINS. U. S. 1,759,960, May 27, 1930. Deck mechanism for a table concentrator, comprising in combination, a deck-supporting carriage, a deck-carrying platform mounted on the carriage at a transverse inclination, a pair of decks mounted upon the platform side by side to extend longitudinally thereof and supported by the carriage at a transverse inclination so that each deck will discharge its tailings along its lower side, and means for supporting the deck near the lower side of the platform in spaced relation to the platform so that the stream of tailings from the upper deck will flow down the platform under the lower deck and combine with the stream of tailings from the lower deck.

Underfeed stoker. ROBERT SANFORD RILEY. U. S. 1,760,256, May 27, 1930. An underfeed stoker comprising a stationary bottom and movable side walls forming a retort therebetween, tuyère blocks on the side walls, a stationary overfeed grate section having tuyère openings therethrough which serves as an extension of the retort bottom and overfeed grate sections on each side of the stationary section which are movable lengthwise of the stoker with the retort side walls.

Spray head. JAMES E. PERRIN. U. S. 1,760,373, May 27, 1930. In a spray head of the class described, inner and outer nozzles mounted for relative rotary adjustment and the outer nozzle having supplemental air discharge passages, a valve between the nozzles for regulating the discharge of air from the supplemental passages and movable by a relative turning of the nozzles, to open or close the passages or to vary the discharge of air therefrom, the actuated movements of the valve being relative to both nozzles.

Traveling-grate stoker. WILLIAM D. YERRICK AND JESS W. PECK. U. S. 1,761,029, June 3, 1930. A stoker comprising a fuel hopper, an endless traveler to carry fuel therefrom into the furnace, fuel supporting members pivoted on the traveler, and means on the members to limit the pivotal movement thereof in each direction so that the members will each assume a fuel supporting position when moving inwardly and will depend in an ash dumping position when returning outwardly.

Grinding cement materials, etc. CARL PONTOPPIDAN. U. S. 1,762,241, June 10, 1930. The improvement in the grinding of cement material, which consists in adding to the material while it is being ground a substance evaporable by the heat developed in grinding whereby, through the absorption of heat in the evaporation of such substance, the temperature of the material being ground is reduced, the substance being added in such quantities and when the temperature of the material is such that the substance is evaporated without absorption by the material.

Drying apparatus for ceramic ware. C. KELLER & CO. G.M.B.H. Ger. 490,627, May 4, 1928. A two-stage steam heated drier is described. (*C.A.*)

Kilns, Furnaces, Fuels, and Combustion

Technical efficiency of continuous kilns. ANON. *Brit. Clayworker*, **39** [457], 54–55 (1930).—A résumé of the report on the results obtained in the firing of various designs of continuous kilns numbering 25 in all, as studied by the Technical Service of the Syndicat de Produits Céramiques de France. The goods fired comprise interlocking tile, hollow brick, fire brick, and building and facing brick. The kilns studied include those of the usual oblong design with either rectangular or semicircular ends, and include also two zigzag kilns. They are operated by chimneys of various heights or by induced draft; only one is fired by gas and half are equipped with stokers. The technical details furnished comprise (1) density of setting in the kilns; (2) moisture in the ware when set; (3) length and cross-sectional dimensions of the kiln galleries; (4) height of chimneys

and pressure of the draft behind the firing zone and at the main smoke flue; (5) length of zones of (*a*) heating, (*b*) firing, and (*c*) cooling; (6) output of ware in tons per 24 hrs.; (7) temperature of (*a*) full firing and (*b*) main flue; (8) percentage of carbonic acid in (*a*) front firing zone and (*b*) main flue; (9) consumption and analysis of coal. It is shown that if the density of the setting is regulated in such degree that the speed of travel of fire is increased there is considerable economy in the amount of fuel consumed. It is shown how fuel consumption is increased by air leakage into the kiln body. The same report also gives valuable information in connection with a study of intermittent kilns. R.A.H.

Annular kilns or twin-kilns with alternate flames. ALFRED OLSEN. *Lerindustrien*, **3**, 15 (1930); *Tonind-Ztg.*, **54** [36], 619 (1930).—The annular kiln is the best and most economic kiln for firing brick, drain pipe, and similar heavy ceramic ware, but O. points out the difficulties of using it for firing face brick of pure color or other objects of high quality. The expense of firing an annular kiln is compared with that of the partially continuous twin kiln also called flame kiln, both having a production of about $^1/_4$ million wall brick per month. The consumption of coal for 1000 brick (23 x 11 x 5.5 cm.) in an annular kiln is about 110 kg. at a cost of 4.8 kronen, and in a twin kiln about 340 kg. costing 9 kronen. Consumption of coal for $^1/_4$ million brick in annular kilns is 27.5 T. at 600 kronen and in twin kilns 85.0 T. at 2000 kronen. O. prefers twin kilns in spite of the high cost of operating them as they guarantee a better production and can be used for firing products of high quality. About 300 to 350 heat units per kg. of brick fired at 960° are needed in an annular kiln and about 1000 heat units in a twin kiln. The consumption of coal also depends on the proper construction of the kiln, the chimney, and local circumstances. M.V.K.

Repairs to continuous-fire kilns when not in operation. J. WELTER. *Rev. mat. constr. trav. pub.*, No. 247, pp. 61–64B (1930). A.J.M.

Stopping a continuous-fire kiln at end of season. J. WELTER. *Rev. mat. constr. trav. pub.*, No. 246, pp. 41–45B (1930). A.J.M.

Gas-fired continuous kilns in the chinaware industry. J. B. NEALEY. *Ceram. Age*, **14** [3], 83–88 (1929); ANON. *Fuels and Fur.*, **7** [12], 1939–42 (1929); *Ceram. Abs.*, **9** [6], 444 (1930). W.W.M.

Dressler "Carboradiant" kiln. ANON. *Brick Clay Rec.*, **76** [11], 716 (1930).—Exclusive rights to the "Carboradiant" furnace have been granted recently to the American Dressler Tunnel Kilns, Inc., Cleveland, Ohio, by the Carborundum Co., patentees of this method of kiln design. While essentially an open-fired type kiln, in principle it is intermediate between the ordinary open-fired and the Dressler muffle types in that combustion may be confined strictly within the furnaces running parallel with the kiln walls. If desired, combustion may be retarded so as to extend the flame well into the loads and among the ware. This feature is optional and is controlled by the volume of preheated air allowed to enter the furnace with the fuel. While it is known that use of fuel oils, and particularly the heavy concentrated grades, in any ordinary type of direct-fired kiln, is dangerous because of the great concentration of heat at points of combustion, this danger is eliminated in this type of kiln. This kiln is designed to make full use of the principle of radiation. Illustrated. E.J.V.

Multi-burner kiln. ANON. *Fuels and Fur.*, **7** [7], 1101 (1929).—A new type of direct fire kiln has been developed by American Dressler Tunnel Kilns, Inc. Kiln efficiency is increased and fuel consumption decreased by close control of atmospheric conditions and use of hot air from the cooling zone for combustion in the heating zone. The large number of burners, which can be run either reducing or oxidizing, give even heat distribution in the heating zone. W.W.M.

Catterson-Smith electric furnace. ANON. *Pottery Gaz.*, **55** [636], 953–55 (1930).—

An electrically heated furnace must be solidly constructed, heavily insulated, and fitted with high-grade forms of heating units, resulting in a somewhat heavy initial cost. Against this outlay can be set advantages such as: (1) that heat may be applied from any desired position, *i.e.*, heaters may be placed in the walls or roof; (2) general absence of dirt, especially inside the heated space; (3) absence of foul gas; (4) ease of working and control, especially important since they can be operated by unskilled persons; (5) general efficiency and extremely low heat loss; (6) low maintenance and running costs; (7) uniformity of temperature; and (8) furnace can be placed in any desired position. Mainly, the materials employed to resist the flow of electrical energy fall within two very distinct classes; (*a*) metal, usually of special alloy containing a large proportion of nickel, and (*b*) recrystallized silicon carbide molded under a secret process into rigid elements of rod form. The safe maximum temperature for the rod element is 1300°C, while for the alloy, a temperature of 1000 should not be exceeded. The furnace produced by Catterson-Smith consists essentially of a box-like structure composed of insulating brick supported within a metal framework and fitted with a hinged door which, when shut, effectively seals the aperture. The heating elements are disposed in the walls of the muffle as required, thus radiating heat through the whole of the interior. The refractory lining is made of sillimanite. The heating elements can be readily replaced in case of a breakdown without the necessity of technical assistance. E.J.V.

Specifications and dimensions for the rational construction of a kiln. ALBERTO PELLACINI. *Corriere ceram.*, **10** [12], 473–77 (1929). M.V.K.

Refractory lining of kilns. HARRAEUS. *Zement*, 130–31 (1930); *Bldg. Abs.*, 79 (March, 1930); *Refrac. Jour.*, **5** [56], 308 (1930).—H. describes three varieties of a clayware kiln crown which consists essentially of a reënforced concrete slab from which the refractory lining is suspended by bolts. Hollow-clay blocks interposed between slab and lining provide an insulating air space, which at the outer wall surface is open to the air. E.P.R.

New crown for ceramic kilns. H. ILLIES. *Feuerungstechnik*, **18** [9–10], 94 (1930).—The firm "Les Voutes Rationelles" in Grenoble, France uses ferro-concrete roofs as the supporting framework in its new kilns. The heavy supporting walls necessary for round arches are avoided as there is no lateral pressure. The rectangular construction makes for economy in kiln space while the production is the same as in other kilns. Firing should be more effective as the gases are distributed more uniformly over the surface and are not gathered on top as in an arch. M.V.K.

Kilns heated by electricity. ANON. *Klei*, **22** [8], 93–96; *Tonind.-Ztg.*, **54** [35], 602, (1930).—Morganite element, an English product, consists of a half porcelain mass and can be molded in any desired shape. The disadvantages which are attached to this element are mainly its short life and the still primitive regulating of the current by hand. They are used, however, in ceramic kilns, *e.g.*, in the tunnel kiln of the plant Gustavsberg in Sweden which is described. Progress in the domain of electrical kiln heating has been made by the Brown Boveri Company in Baden, Sweden. M.V.K.

Electric furnaces with controllable atmospheres (copper). C. L. HEISLER, JR. *Ind. Eng.*, **88** [3], 136–38 (1930).—Atmospheric conditions in electric furnaces for heat treating are briefly described. Normal atmospheres are present in box-type furnaces where the mass of the charge is small compared to the heating chamber. The atmosphere can, however, be depleted of O by the introduction of carbonaceous material or N gas. In the bright annealing of Cu a water-seal furnace is frequently used and the air is excluded from the chamber by the introduction of superheated steam. The elevator type furnace, suitable for annealing steel products, is also described. The load is generally large in proportion to the size of the chamber and as heating proceeds the O disappears. The conditions are such that at the end of 10 hrs. the percentages change from

0.15 to 0.0% O_2, and from 22.05 to 72.55% N_2. The Cu brazing furnace is especially adaptable to uniting several parts of intricate shapes into a unit. The H acts as a flux and at the melting point of Cu the steel parts are joined. A hydrogenated cooling chamber is provided with the furnace proper. (*C.A.*)

Reduction of the consumption of fuel in periodical kilns. ANON. *La Céramique*, **50**, 1–6 (1930); *Tonind.-Ztg.*, **54** [34], 586 (1930).—A lecture of Marceau Gabillon at the Technical Congress of the French ceramic industry included a description of the processes taking place during firing; also an approximation of the fuel lost with different kinds of firing and arrangements of furnaces. This is illustrated by an example. An explanation of how to obtain a 50% economy of fuel is given. M.V.K.

Coal processing and clay firing. GEORGE W. BURKE. *Ceram. Age*, **14** [1], 3 (1929).—A brief technical comment on coal and coal carbonization, in connection with the firing of clay ware, with especial reference to Iowa coals. W.W.M.

Firing Iowa clays. EXPERT. *Clay-Worker*, **93** [6], 413 (1930).—Drain tile manufacturers in Iowa experience a lot of trouble in firing drain tile to a dark, hard-looking color. Such clays fire to a light color. The only way to overcome this defect is to finish the kiln during the last stages of the firing with an alternating oxidizing and reducing heat, and for the last few fires maintain a heavy, continuous reducing heat, dropping the dampers until the fires just draw in, creating smoky fires with a shovel of salt with the first fire and follow up the smoke, never letting the kiln clear. During this operation do not let the heat increase above the point that the clay will stand without overfiring or getting out of shape. This method produces at least a brown color, but is not glazed from the salt. E.J.V.

Calculation of air used in combustive reactions. W. C. BUELL, JR. *Fuels and Fur.*, **7** [12], 1847–51 (1929).—B. discusses sampling of furnace gases and the apparatus necessary. He describes a graphic method of calculating the percentage of air required for combustion. W.W.M.

Modern coke oven and by-product recovery plant. D. V. HOLLINGWORTH. *Colliery Guardian*, **140** [3621], 1931–36 (1930).—Modern requirements of a coke oven over the old types were (1) an increase in the throughput of coal per oven per day; (2) consumption of less heat during the coking process; (3) greater use of labor-saving devices; and (4) fullest possible production and utilization of all the by-products of carbonization, including the gas evolved. The attainment of these desirable results involved (1) quicker transference of heat from the heating gases to the coal in the oven; (2) use of much higher temperatures than had been customary; (3) a considerable increase in the size of the oven; and (4) more complete regeneration of the heat of the waste gases, which in turn necessitated (*a*) employment of a more refractory building material, *i.e.*, silica, and (*b*) a narrow oven. Where in the old oven the fire brick used consisted of 84% silica, the new ovens recently installed at Altham, England, use a high-grade silica brick containing 96 to 98% SiO_2 in all parts subjected to the higher temperatures. During the construction the brick were tested for heat-resisting quality and were found to withstand a temperature of 1690°C and upward under a load of 50 lb. per sq. in. without softening. Extra precautions were taken to allow for and control the expansion of the silica work. Data on the expansion of silica ovens during heating up is presented in tabular form, as are the characteristics of ancient and modern coke ovens for the purpose of comparison of old and new practice. The operation of the coke oven is described in detail. Illustrated. E.J.V.

Eliminating smoke in ceramic plants. GEORGE A. BOLE. *Ceram. Age*, **14** [2], 47–50 (1929); see *Ceram. Abs.*, **8** [6], 438 (1929). W.W.M.

Estimation of liquid fuels. W. STEINITZ. *Tonind.-Ztg.*, **54** [29], 494–95; [30], 511–12 (1930).—S. discusses the qualities of liquid fuels used in Germany. He gives

data on their energy content, specific gravity, volatility with boiling test diagrams, reaction to compression, motive power, spirits as fuel, motor oil, and prices of the fuels. M.V.K.

Estimation of naphthalene in oils and coal gas. S. TWEEDY. *Colliery Guardian*, **140** [3620], 1842 (1930).—A method for the estimation of naphthalene in oils and coal gas for control purposes consists essentially of vaporizing the naphthalene and passing the vapor through picric acid solution, afterward filtering the naphthalene picrate precipitate and estimating the amount of combined picric acid. Details of the method are given. E.J.V.

Mechanism of combustion. VII. D. J. DEMOREST. *Fuels and Fur.*, **7** [7], 1009–12 (1929).—D. discusses the mechanism of combustion, the nature of the surface of a fuel, its catalytic action, and the reactions at these surfaces. **VIII. Relation between thermal capacity and temperature of combustion.** *Ibid.*, **7** [8], 1147–50 (1929).—D. covers the temperature of combustion of the fuels and its relation to thermal capacity. He also includes the temperature of ignition and a graphic method of calculating variation of thermal capacity with temperature of combustion is shown. **IX. Flame propagation of combustible gases.** *Ibid.*, **7** [9], 1413–17 (1929).—D. discusses combustion, covering the propagation of flames and the effect of moisture in the gas. He gives several illustrative problems with their solutions. **X. Industrial gasmaking processes.** *Ibid.*, **7** [11], 1679–86 (1929).—D. discusses the technical operations whereby fuels are made and used, covering in this article the operations of and reactions occurring in a gas producer and the effect of steam, temperature, and depth of fuel bed. Tables and graphs are shown. For Parts V and VI see *Ceram. Abs.*, **9** [6], 461 (1930). W.W.M.

Behavior of soluble salts in clays. A. SIMON AND K. SCHMEIDER. *Z. angew. Chem.*, **19,** 380–82 (1930); *Tonind.-Ztg.*, **54** [39], 669 (1930).—The formation of gypsum efflorescences and the effect of firing at high temperatures was investigated on white ware. Parallel conclusions may be drawn for brick firing. Clay-lime pastes were fired by electricity at definite temperature intervals in a special apparatus containing air with a certain sulphurous acid content. The absorption of sulphurous acid by bodies is increased when the air contains SO_2, but the chemical laboratory of Tonind.-Ztg. (*Tonind.-Ztg.*, **84,** 1149 (1912)) found that small quantities of sulphate do not act injuriously as they retain so much hygroscopic water. Absorption of sulphurous acid takes place between 300 to 600°, therefore the temperature should be raised as quickly as possible to 750° where absorption ceases. If the efflorescences are already formed, a very high temperature is needed to decompose them, 1000° being insufficient. Therefore the air for drying and preheating should be free from sulphur if possible, while coal containing sulphur may be used for firing at very high temperatures. M.V.K.

Heat content of slags. G. NAESER. *Stahl Eisen*, **50** [17], 554 (1930).—N. reports on measurements of the specific heat of Siemens-Martin slags up to temperatures a little above the fusing point. A table is given showing the heat content of different Siemens-Martin slags. The results correspond to the specifications of S. Umino in his recent work (*Science Rept., Tohôku Univ.* [Japan], **5,** 985 (1928)). The influence of considerable variations in chemical compositions on the heat content was shown to be small; the values therefore can be used for metallurgical calculations of systems which contain differently composed slags. M.V.K.

Theory of heat conduction. M. S. VAN DUSEN. Bur. Stand., *Jour. Research*, **4** [6], 753–56 (1930).—A simple transformation for heat flow is given which does not appear to be generally known. By means of this transformation most problems in steady heat flow with conductivity depending on temperature can be derived directly from the solutions of the same problems where the conductivity is assumed constant. The paper is entirely mathematical. R.A.H.

Pulverized coal as industrial fuel. ANON. *Black & White; Pit and Quarry*, **20** [4], 53–56 (1930).—Advantages, disadvantages, preparation, and use are described. E.P.R.

Comparative tests of fuels used for heating domestic boilers. E. S. MALLOCH AND L. E. BALTZER. *Colliery Guardian*, **140** [3620], 1841–43 (1930).—In all, 21 different fuels were tested. Data in regard to the relative values of the fuels tested, based on quantity of fuel fired per therm delivered, average values for the fixed carbon and volatile matter content of the fuels and the variation in the over-all thermal efficiency of the accepted tests are given. Generally, it may be assumed that higher efficiency will result when burning a fuel high in fixed carbon content, where combustion is completed in or close to the fuel bed, than when burning a fuel high in volatile matter content, which when burning gives off a great amount of combustible gas that may or may not be burned. The tests on American anthracite coal did not prove as satisfactory as had been hoped, although the tests showed clearly the advantages of high thermal efficiency, small amount of attention required, and absence of clinker formation except at very high loads. The chief disadvantages are the large amount of refuse which had to be removed per ton of fuel fired and, to a lesser degree, the slightly larger amount of fuel fired per therm delivered, in comparison with the cokes, the British anthracites, and the semibutiminous coals. Both Welsh anthracite and Scotch semi-anthracites gave good results in the tests. Welsh anthracite gives a high efficiency, very little refuse has to be removed, and the fire requires very little attention. E.J.V.

Combustion in theory and practice. H. L. KAUFFMAN. *Brick Clay Rec.*, **76** [10], 647–52 (1930).—All fuels used in the commercial production of heat by combustion contain carbon in some form, either as solid carbon of a high degree of purity or combined with hydrogen in the form of hydrocarbons. In addition to the principal heat-producing elements, coal, especially, contains a varying percentage of incombustible waste matter called ash; while both coal and oil contain sulphur compounds in different amounts. In coals, the sulphur or sulphur compounds form an exceptionally high percentage of the total weight; ordinarily being several times the quantity found in the average fuel oil. Sulphur in its different forms not only contributes little to the production of heat, but is actually detrimental particularly to such products as face brick and terra cotta. The ash content of fuel oil is negligible. The heat value of a fuel depends on the proportion of the chemical elements contained therein. Combustion is a chemical process in which the oxygen of the air enters into combination with the combustible elements of the fuel, heat being evolved during the oxidizing process. Theoretically, perfect combustion is simple, consisting as it does in bringing each particle of fuel (heated to its ignition temperature) into intimate contact with the correct amount of oxygen supplied from the air. Actually, however, under ordinary practical conditions the process is usually quite complicated, due, first, to the fact that carbon combines with oxygen in two different proportions to form two different chemical combustion products; and second, because when hydrocarbons are present the chemical reactions are still more complicated owing to the moisture produced by the combustion of the hydrogen and the decomposition or "breaking-up" of the hydrocarbon compounds, which may absorb heat rather than produce it. The chemistry of the combustion of carbon and hydrogen or hydrocarbons is explained. Considerable information relative to the properties of air is given. Air at all temperatures considered for furnace work behaves as a perfect gas. Formulas for the determination of the theoretical total weight or volume of air for the combustion of one pound of fuel are given. The temperature of combustion is chiefly dependent upon the volume of air necessary for complete burning of the fuel. If a large volume of air is required, then heat is used in raising this air to the ignition temperature; therefore, the temperature of the burning fuel is less than would prevail under conditions

wherein a smaller volume of air is necessary. The volume of the gaseous products of combustion and the specific heat of these gases influence the temperature of combustion, as does also the rapidity with which the fuel is consumed. Three distinct factors are involved in obtaining efficient combustion in practice: (1) sufficient air for oxidation, (2) thorough mixture of the air and fuel particles, and (3) proper ignition temperature. A formula to use in order to calculate the loss due to incomplete combustion to carbon monoxide is given. For maximum efficiency in the burning of coal, oil, or any other fuel, the air supply must be so adjusted that the heat lost by the production of carbon monoxide is just balanced by the heat taken away through the stack by the excess air. Hydrocarbon compounds present in both coal and oil "crack" (decompose) to some extent when they are heated above a certain critical temperature in the absence of a sufficient quantity of oxygen for combustion. In order to obtain a maximum amount of heat from a fuel it must be burned as rapidly as possible. Theoretically, for efficient combustion, each particle of fuel should be entirely surrounded by just enough air or oxygen required for its combustion. Fuel oil is burned either in the form of a spray or in the form of a vapor. All coals contain ash, moisture, and sulphur. These substances possess no heating value. Fuel oils contain traces of moisture and ash, and all contain some sulphur, though sulphur is usually present in oil in much smaller percentage proportions than in coal. The ash content of coal ranges from 5 to 15%, in fuel oil it is never more than a few tenths of one per cent. The presence of moisture in coal has the same general effect as ash, except for the expense of removal. Large quantities of sulphur in either coal or oil are objectionable for ceramic purposes. A grade of oil is generally available, however, in which the sulphur content is not prohibitive for the particular use desired of it. E.J.V.

Valuation of a furnace. W. GUMZ. *Feuerungstechnik*, **18** [3–4], 2123 (1930).—In rating a furnace the following points must be considered: (1) fuel: its quality, ignition properties, rate of burning, water and ash content; the formation of slags, their fusing point, and their chemical action on the walls of the kiln; (2) combustion air, its proper mixing with gases in the firing chamber, regulating the supply, preheating; (3) combustion gases and their volume; (4) transportation of fuel by special apparatuses; and (5) questions of supply, management, and maintenance prices. M.V.K.

Ivo draft stabilizer. ANON. *Pottery Gaz.*, **55** [636], 953 (1930).—It is claimed that the Ivo draft stabilizer effects a substantial economy in fuel consumption, whether solid or oil fuel is used, in many instances as much as 20%. The apparatus is fitted to the flue or chimney, and its function is to ensure that a constant volume of air passes through the furnace and it regulates itself automatically to the condition of the fire. Whenever an excess amount of air is drawn through the furnace because of draft variations the draft stabilizer opens automatically allowing the extra air to enter the chimney separately, thus avoiding the wastage of heat energy in the furnace and maintaining the temperature steady. The stabilizer can be easily fitted by an engineer, stoker, or bricklayer, working from the instructions supplied, and in many cases without drawing the fires. Four sizes are made. Illustrated. E.J.V.

Retort charging machine. G. L. SPENCER. *Eng. Mining Jour.*, **129** [10], 503–504 (1930). E.C.C.

New flow meter checks up combustion mixtures. ANON. *Pit and Quarry*, **20** [4], 83 (1930).—A novel type of flow meter is being manufactured by the Meriam Co., Cleveland, for the purpose of measuring the mixture of liquid or gaseous fuel used in furnaces for annealing, heat-treating, heating, chemical, and process operating. The new instrument is made up of a series of compact manometer units. E.P.R.

Calculation of regenerators. K. RUMMEL AND A. SCHACK. *Stahl Eisen*, **49** [36], 1300–11 (1929).—Equations for the calculation of temperatures and of exchanged quan-

tities of heat from regenerators are compiled; the calculations are explained in detail by an example. M.V.K.

Chimney draft or ventilator. ANON. *Lerindustrien*, **3**, 14 (1930); *Tonind.-Ztg.*, **54** [40], 684 (1930).—Chimneys for rotary kilns must be either built with an interior diameter and height sufficient to insure a good furnace draft even during warm quiet weather, or ventilators should be installed. The expenses of working and operating a ventilator are given. M.V.K.

New oil burner in glass plant. ANON. *Nat. Glass Budget*, **46** [6], 22 (1930).—A new type of oil burner known as the "Ray" burner has been installed on the sand drier at the Fabrica de Botellas, Havana, Cuba. Either light or heavy oil can be used in these burners which is an advantage over other types of burners which will work efficiently with only one grade of oil. If these burners prove to be as satisfactory as is hoped, the glass industry could profitably use many of them. E.P.R.

BOOK AND BULLETINS

Coal Dust Firing. (Kohlenstaubfeuerungen). HERM. BLEIBTREU. 2nd ed. Julius Springer, Berlin, 1930. 495 pp. Rm. 39.00. Reviewed in *Tonind.-Ztg.*, **54** [35], 600 (1930).—B. divided his work into three parts: (1) description of the coal dust and its preparation for use; questions as to transport, arrangement of work, preparation of installations, etc., are discussed; (2) description of all industrial kilns which can be used for coal dust firing, among which are cement, lime, and glass furnaces; (3) installations for boilers. Firing of stationary boilers, engines, and ship boilers is discussed. M.V.K.

Fuel-burning and steam-generating equipment. ANON. *Pit and Quarry*, **19** [3], 114 (1929).—Catalog GC-5 of the Combustion Engineering Corp. describes and illustrates various types of coal pulverizers, pulverized-fuel furnaces, air preheaters, underfeed and grate stokers, combustion steam generators, and boilers. E.P.R.

"Purfeco" pulverized coal systems. ANON. *Pit and Quarry*, **20** [5], 80 (1930).—Catalog No. 4 of the Pulverized Fuel Equipment Co. describes and illustrates complete pulverized fuel systems. E.P.R.

PATENTS

Furnace air preheater. ROBERT SANFORD RILEY. U. S. 1,759,916, May 27, 1930. A heat exchange apparatus comprising a cylindrical drum havings its axis arranged vertically, radial partitions and walls arranged to form passages within the drum communicating at both ends with openings through the top wall of the drum, heat exchange material in the passages, means for admitting heated and cold gases, and a rotatable valve casing slidably and rotatably mounted on the top of the drum which has passages therethrough and is arranged to transmit the heated and cold gases alternately and successively through the different passages of the drum to effect a heat exchange therein.

Combined starting and mixing chamber for liquid-fuel burners. JAMES IRONSIDE. U. S. 1,760,412, May 27, 1930. A combined starting and mixing chamber for liquid fuel burners, comprising a housing provided with a passageway for conducting air to the vaporized fuel and another passageway for conducting the vaporized fuel toward the burner or burners, and a combined closure and starting member rotatably mounted on the housing and adapted to close the upper part of the second passageway from the atmosphere and place the same in communication with the first passageway in one position of rotation.

Tunnel kiln. THURE LARSSON. U. S. 1,763,624, June 10, 1930. A tunnel kiln comprising a combustion chamber, a burner associated with the chamber, conduits for conducting fuel and air to the burner, a heat exchange device independent of the kiln for preheating the air delivered to the burner, means for withdrawing the products of com-

bustion from the combustion chamber and delivering them to the heat exchange device, an exit flue for the products of combustion leading from the device, and means for mixing a cooler gas with the products of combustion before they enter the exit flue.

Composite fuel. J. A. GREENE AND BINDPHAST PRODUCTS, LTD. Brit. 324,081; *Colliery Guardian*, **140** [3620], 1889 (1930).—The invention consists of a composite fuel which comprises a bituminous or like combustible substance such as small coal and a preferably relatively small quantity of calcined dolomite wherein during manufacture a solution of chlorine in water or dilute hydrochloric acid is used to form a plastic coherent mass. According to one embodiment of the invention, a quantity of small coal, or a mixture of bituminous substances adapted to form a combustible base, is thoroughly mixed with a relatively small quantity of calcined dolomite, *i.e.*, 35 parts of calcined dolomite to 100 parts of combustible base. The mixture is then treated with a solution of chlorine in water, or with dilute hydrochloric acid in quantity sufficient to convert the mixture into a plastic coherent mass. Alternatively, a plastic coherent mass may be produced by first mixing the required proportions of calcined dolomite and chlorine solution or dilute hydrochloric acid together, and then adding to it the small coal or other bituminous or like combustible substances in quantity sufficient to produce a mass of the desired consistency. The mass so produced may then be molded and subjected, if necessary, to a suitable pressure. Drying of the resulting blocks or briquettes may be effected either by stacking the same when removed from the molds or they may be left in the molds to dry. In order to make the mixture dry more quickly after molding, a small quantity of powdered alum, 5%, or other suitable substance may be added to the mass before molding. Where a slow-burning fuel is required, a small quantity of clay or other suitable noncombustible substance may be added to the mixture of combustible base and calcined dolomite. E.J.V.

Coke. M. H. HUE. Brit. 322,713, Feb. 5, 1930; *Colliery Guardian*, **140** [3607], 665–66 (1930). Material for making coke comprises the dust or waste of anthracite or other mineral fuels agglomerated with a binder consisting of petroleum pitch, fuel oil, and a vegetable oil. The fuel after a preliminary coking in retorts heated to 1200°C is ground, mixed with the binder, and pressed, the agglomerates being heated in ovens at 300 to 400°C for a period, *e.g.*, $1^1/_2$ hours, which may vary with the fuel. The binder may consist of 65% of petroleum pitch, 24% of fuel oil, 6% of cotton seed oil, and 5% of water and the substances may be mixed at about 60°C, a proportion of 5 to 25% of the mixture being employed to 95 to 75% of the fuel.

Kilns. J. W. JONES AND S. JONES. Brit. 327,396, May 28, 1930. In a multi-chambered continuous kiln two fireplaces are provided for each chamber, one being at a higher level than the other. The lower fireplaces of the grate bottom type, are arranged in front of the connecting passages between adjacent kiln chambers, while the higher level solid bottom fireplaces are above these passages. Hot air may be taken off from the chambers through ports to a main flue, and passed into other chambers through ports which can also be put into communication with the main exhaust flue.

Tunnel furnaces. H. M. ROBERTSON. Brit. 327,486, May 28, 1930. A furnace for the heat treatment of metal articles and for baking clay goods and enameled ware comprises side combustion chambers communicating with a common flue above the roof of the heating chamber. The conveyer comprises endless chains running on water-cooled tracks at the base of the furnace, and on angle tracks in the chamber, upstanding arms, and transverse charge supports. The arms are cranked, so that the chains can be located beneath projecting brick and so protected from the direct heat of the chamber. The ends of the furnace are closed by vertically adjustable doors which may have chains depending from their lower edges to prevent admission of air.

Furnace wall. AMERICAN ENGINEERING CO. Brit. 327,862, June 5, 1930. A fur-

nace wall of the kind comprising an inner wall embodying a tubular frame-work through which fluid is circulated and an outer wall separated from the inner wall by an air passage, has the inner wall mounted on an open framework which carries an upper wall section, a lower wall section, and a fluid-cooled panel of the form described in Brit. 297,094 comprising vertical and inclined rows of recessed blocks clamped to water tubes by bolts passing through angle members.

Annular kiln. PAUL DONNERHAK. Ger. 489,065, Oct. 1, 1926. A construction of kiln is described of the type having tubes built into the hearth and (or) the cover, to provide warm air for drying purposes. (*C.A.*)

Ceramic kilns. AUGUST HUNDECKE. Ger. 490,801, Dec. 25, 1928. An annular kiln for brick firing, etc., is subjected to a drying current of smoke-free flue gas. See also Ger. 481,057; *Ceram. Abs.*, **9** [1], 58 (1930). (C.*A.*)

Geology

Base exchange between clay and solutions of sodium salts and its relation to the formation of coal and petroleum. E. MCKENZIE TAYLOR. *South African Jour. Sci.*, **26,** 57–69 (1929); for abstract see *Ceram. Abs.*, **8** [12], 926 (1929). (*C.A.*)

"Boehmite" of the bauxites. HOCART AND DE LAPPARENT. *Ciment,* **35** [1], 8 (1930); *Rock Prod.*, **33** [9], 80 (1930).—H. and L. in a recent paper delivered at the French Academy of the Sciences meeting, report that one of them has indicated in certain bauxites the existence of microscopic crystals of a monohydrate of alumina (Al_2O_3HO), which he designated boehmite, of orthorhombic symmetry but differing from diaspore in certain properties. Previously Boehm, in studying the radiograms, realized that the action of X-rays (Debye and Scherrer process) upon certain hydrates of alumina and on some bauxites, had shown that the existence of a monohydrate of alumina can be deducted. He designated bauxite homologous with the lepidocrocite ($Fe_2O_3H_2O$), the diaspore being the other part homologous to the goethite. With some radiograms obtained by one of the authors (Debye and Scherrer process) of the lepidocrocite as well as the boehmite, they have been able to amass small crystals in sufficient number (bauxites of Pereille, Ariege) showing a correspondence of lines which leaves no doubt as to the structural relation of these two minerals. Moreover, the lines of the radiogram of the "boehmite" corresponded to those that may be observed in the radiogram of "bauxite" obtained by Boehm. The theories made by one of the authors on the diaspore of certain bauxites from the Fenouillet deposits is confirmed by an accurate radiogram of these bauxites, and shown to correspond to a radiogram of goethite. Thus, the homology of the boehmite and of the lepidocrocite on one hand, and the diaspore and the goethite on the other hand, is found to be clearly proven. W.W.M.

Laterite. J. B. SCRIVENOR. *Malayan Agr. Jour.*, **17,** 454–59 (1930).—Laterite was originally described as an indurated clay which formed natural brick on cutting and drying. It is a common weathering product of rocks found in most tropical countries. The term has been greatly misused and misdefined. Al hydroxide is not a necessary constituent. (*C.A.*)

Clay formation and the weathering of feldspars. O. TAMM. *Medd. Stat. Skogsförsöksanst.*, **25,** 1–28 (1929); *Proc. Internat. Soc. Soil Sci.*, **4,** 347–48 (1929).—Feldspars were pulverized in the presence of water in a mill producing ultimate particles of 2 to 0.2 μ in diameter. In the case of microcline and oligoclase sufficient decomposition occurs to produce an alkaline reaction reaching p_H 10.7 and 11.1, respectively, for the two minerals. The decomposition products absorb water in amounts which increase with the fineness of grinding. This water is not removed by drying at 105 to 110° nor *in vacuo* over sulphuric acid at ordinary temperatures. The decomposed particles of

microcline exhibit base-exchanging properties within the range p_H 6 to 10. Under acid conditions (p_H 6 to 3) there is a steady decomposition of the particles, and soluble alkalis and aluminum appear. Feldspar particles of less than 0.5μ in diameter react with hydrogen ions to an extent which increases with decreasing diameter of the particles. Particles of >2μ in diameter are not appreciably reactive. The weathering of minerals in soil involves processes and materials similar to the above. (*B.C.A.*)

Sedimentary kaolins of Georgia. RICHARD W. SMITH. Geol. Surv. of Ga., *Bull.*, No. 44; *Ceram. Age*, **14** [2], 39–45 (1929); see *Ceram. Abs.*, **8** [11], 841 (1929). W.W.M.

Aluminum production in U. S. S. R. ANON. *Econ. Rev. Soviet Union*, **5** [2], 43 (1930).—The recent discovery of bauxite deposits in Russia will furnish a national source of aluminum ores which were heretofore imported. The most important deposits are in the Tikhvin district and contain over 8 million T., with a high percentage of aluminum ranging from 35 to 71% Al_2O_3. M.V.K.

Silica in 1928. ESTELLE R. PHILLIPS AND J. A. DORSEY. Bur. Mines, *Mineral Resources U.S.*, Part II, pp. 221–25 (1928).—The production of quartz (crude and ground) from pegmatite dikes, from veins, and from quartzite increased 0.2% in quantity and 8% in value in 1928, as compared with 1927. Ground sand and sandstone increased 2% in quantity and 4% in value. Ground sand and sandstone amounting to 280,402 short T. valued at $1,966,295, was sold or used in 1928 by producers in Calif., Ill., Mo., N.J., Ohio, Pa., Va., W. Va., and Wis. Data on imports of flint, flints, and flint stones are given. R.A.H.

Zinc in 1928. ELMER W. PEHRSON. Bur. Mines, *Mineral Resources U.S.*, Part I, pp. 363–421 (1928).—From a statistical point of view the decline in the zinc industry of the U.S. which began in the latter part of 1925, came to a definite end early in 1928. The apparent consumption of primary zinc in 1928 was a record for all time and was 12% greater than in 1927. The production of primary zinc in the U.S. in 1928 increased 10,065 T. or 1.7% over 1927, amounting to 591,525 short T. The report gives detailed statistics on distilled and electrolytic rolled zinc, zinc pigments and salts, and secondary zinc as well as on the world zinc industry. R.A.H.

Tin in 1928. CHARLES W. MERRILL. Bur. Mines, *Mineral Resources U.S.*, Part I, pp. 321–46 (1928).—The world mine production of tin in 1928 amounted to 179,000 long T., an increase of 12% over the 160,015 T. produced in 1927. The total value of the imports in 1928 was $86,983,174, a decrease of 14% from the value of imports in 1927. The report gives detailed statistics on imports and exports, consumption, prices, and stocks. R.A.H.

Clay in 1928. JEFFERSON MIDDLETON. Bur. Mines, *Mineral Resources U.S.*, Part II, pp. 187–96 (1928); for abstract see *Ceram. Abs.*, **9** [5], 395 (1930). R.A.H.

Production of magnesium and its compounds in the U.S. ANON. *Pit and Quarry*, **20** [3], 56 (1930).—Magnesite, the normal carbonate of magnesium, and dolomite, or high-magnesium limestone, formerly were the only commercial sources of magnesium products in the U.S. For many years Germany was the main source of natural salts found abundantly in the Stassfurt deposits. During the World War magnesium chloride and sulphate began to be produced as by-products of the treatment of brines in Michigan, and within the last year or two experiments have been made in California to produce the salts from sea water. Recently a deposit of brucite (magnesium hydrate) was discovered in Nevada which may be of commercial importance. E.P.R.

Texas silica deposit to be developed. ANON. *Rock Prod.*, **33** [11], 67 (1930).—A clean, fine-grained sand of nearly 100% pure silica is to be mined near Uvalde, Texas. W.W.M.

Geophysical prospecting for minerals. ARNOLDO ZABELLI. *Mining Jour.*, **169**

[4938], 288 (1930).—On account of the general, theoretical, experimental, and industrial interest in geophysics, the U. S. Bureau of Mines has undertaken the task of collecting and publishing the results obtained in the course of geophysical exploration effected in the U.S. and abroad by all those occupied in such questions. A discussion of this undertaking is given. E.C.C.

Chromite of the South African Bushveld. ANON. *Mining Jour.*, **169** [4940], 345 (1930). E.C.C.

Ceylon graphite. STAFF CORRESPONDENT. *Mining Jour.*, **169** [4940], 330 (1930).—The exports of graphite from Ceylon for 1929 showed a decrease over 1928, but the average value per ton realized was Rs 214.28 against Rs 188.51 an increase of Rs 25.77 per ton. The actual figures for 1929 exports were 12,739 T. compared with 1928 exports of 14,347 T., and the value was Rs 2,729,639 against 1928 Rs 2,704,359. E.C.C.

Calite a new ceramic industrial material. ANON. *Chem. Fabr.*, **50**, 525 (1929); *Tonind.-Ztg.*, **54** [26], 455 (1930).—Calite is a magnesium silicate similar to steatite especially pure and free from iron. M.V.K.

Classification and ownership of the minerals of Panama. ANON. *Pit and Quarry*, **20** [4], 52 (1930).—On the basis of ownership and operation rights the minerals of Panama may be classified as follows: (1) building and decorative stone, together with sand, slate, clay, lime, pozzuolana, peat, etc., belong either to the soil owner or, when found on uncultivated and unenclosed land of the state or municipalities, are common in regard to exploitation. These corporations, however, reserve the rights in such cases to enter into special contracts for working them. (2) Metals and precious stones found isolated in a natural condition on the surface. These belong to the first occupant. (3) Gold-bearing and tin-bearing sands can be appropriated without restriction. E.P.R.

Phosphate rock, locations of deposit, and mining methods employed. ANON. *Pit and Quarry*, **20** [4], 44–45 (1930).—Phosphate rock deposits of present or recent economic importance occur in the Atlantic Coast States, in Fla., and S.C.; in the Mississippi Valley region, in Tenn., Ky., and Ark., and in the Rocky Mountain region, in Idaho, Mont., and Wyo. The different deposits differ widely in age, structure, and other characteristics. Depending mainly upon the thickness of the over-burden, phosphate rock deposits are mined either by open-pit or by underground mining methods. E.P.R.

Fluorspar in Canada. ANON. *Pottery Gaz.*, **55** [636], 1012 (1930).—Fluorspar is widely distributed throughout Canada, but most of the known occurrences are of mineralogical interest only. There are two producing localities, near Madoc, Ontario, and near Grand Forks, British Columbia. There was no production in 1926 to 1928. The output for 1929 was 70 T. from Ontario and 17,870 T. from British Columbia. The deposit worked at the Rock Candy mine, near Grand Forks, British Columbia, consists of one large ore-shoot made up of an intricate network of more or less parallel replacement veins varying in width from a few inches to 30 feet in a mass of syenite. At Madoc, Ontario, the mineral occurs in veins in nearly horizontal Paleozoic sediments and in the pre-Cambrian complex on which the Paleozoic sediments rest. E.J.V.

Potash deposits in Russia. ANON. *Econ. Rev. Soviet Union*, **4** [14–15], 259 (1929).—The Solikamsk potash beds located near the upper Kama River in the Urals are perhaps the largest in the world totaling 350 to 450 million T. of potash, while the moderate depth and great thickness of the beds, the high potassium content and the absence of magnesium sulphate establish them as the most valuable. Work is begun and the production for 1929 to 1930 is estimated at 500,000 T. potassium salt, to be doubled or trebled in the following years. M.V.K.

Barite and barium products in 1928. R. M. SANTMYERS AND B. H. STODDARD.

Bur. Mines, *Mineral Resources U.S.*, Part II, pp. 227–35 (1928).—The quantity of crude barite sold or used by producers during 1928 showed a substantial increase over 1927 and represents the largest annual output ever recorded. The amount produced in 1928 was 269,544 short T. compared to 254,265 short T. in 1927. The average value per ton f.o.b. mine of barite sold in 1928 was the lowest since 1917. The report gives detailed statistics on consumption by uses, imports, world production, and barium products. A list of producers is included. R.A.H.

Gypsum in 1928. R. M. SANTMYERS AND JEFFERSON MIDDLETON. Bur. Mines, *Mineral Resources U.S.*, Part II, pp. 155–74 (1928).—The gypsum industry in 1928 was more or less disorganized because of severe competition and price cutting. The quantity of crude gypsum mined in the U.S. in 1928 was 5,102,250 short T., a decrease of 244,638 T. or 5%, compared with 1927. The number of operators in 1928 was 58, a decrease of 2 from 1927. The value of sales of uncalcined and calcined gypsum by producers was $32,036,163, as compared with $42,174,454 in 1927. The report gives detailed statistics on production, kettles and kilns in operation, prices and markets, imports and exports, world production, and discusses synthetic gypsum. R.A.H.

Gypsum in Nova Scotia. J. P. MESSERVEY. *Can. Chem. Met.*, **14** [5], 158–59 (1930).—Gypsum was mined in Nova Scotia as early as 1829, but it is in recent years that the industry has had its most remarkable expansion. The past year's output of 1,021,000 T. is more than three times that of all the rest of Canada. Figures showing the rapid increase in production are quoted. E.J.V.

Canada's diatomite deposits. V. I. EARDLEY-WILMOT. *Mining Ind. Rec.*, **33** [4], 70 (1930).—Diatomite is an extremely light fluffy material composed of myriads of minute, highly porous, siliceous skeletons of diatoms. The uses of diatomite are many and varied but its industrial uses fall into three chief classes: (1) insulation (both heat and sound), (2) filtering, and (3) as an admixture in concretes and plasters. As an insulator against the passage of sound, diatomite has few equals and has the advantage of being absolutely fireproof. As an insulator against heat it is one of the few materials that will effectively withstand very high temperatures. Its field of application ranges from household furnaces, water pipes, boilers, etc., up to furnaces used in the manufacture of steels and the smelting industry, as it can be conveniently molded into pipe covering, slabs, and brick. In the filtering of certain solutions diatomite is now recognized as one of the best known media for accomplishing rapid and clear filtration. As an admixture in concrete the use of diatomite has greatly increased during the last two years. Canada has a large number of diatomite deposits in British Columbia, Ontario, and in the Maritime Provinces. Diatomite suitable for almost every known use can be obtained from these deposits. See also *Ceram. Abs.*, **8** [6], 427 (1929). E.J.V.

Asbestos in 1928. OLIVER BOWLES AND B. H. STODDARD. Bur. Mines, *Mineral Resources U.S.*, Part II, pp. 97–111 (1928).—The total quantity of asbestos sold by producers in the U.S. in 1928 was 2239 short T., valued at $351,178. Canada produced a total of 295,821 T. valued at $11,251,840, average value of $41.16. Rhodesia produced 39,960 T. and Union of South Africa 24,054 T. Cyprus exported 16,287 long T. and Russia 11,147. The report discusses the properties, varieties, uses, and grades of asbestos. R.A.H.

Talc and soapstone in 1928. OLIVER BOWLES AND B. H. STODDARD. Bur. Mines, *Mineral Resources U.S.*, Part II, pp. 197–204 (1928).—Sales of talc by producers in the U.S. during 1928 amounted to 202,976 short T. valued at $2,537,994; they comprised 6360 T. of crude talc, valued at $48,031; 936 T., of sawed and manufactured talc, valued at $70,394; and 195,680 T. of ground talc, valued at $2,419,569. Total sales in 1928 increased 5.5% in quantity and 13.6% in value over 1927. Crude talc increased 11.5% in quantity and 89.4% in value. The report discusses the composition and prop-

erties of talc, uses, reviews the industry by states, gives a list of producers, reviews world production, and includes statistics on imports and exports. R.A.H.

New beryllium deposits. ANON. *Glass Ind.*, **11** [6], 139 (1930).—General Electric Corp. is reported to have secured a controlling interest in beryllium ore deposits recently discovered near Koflach in Stiermark, Austria. In the opinion that the Austrian deposits will supply the world's needs, it has been decided to shut down the Dakota mine. E.J.V.

Vanadium in mineral oil ash. K. BROZ. *Arhiv za Hemiju i Farmaciju*, **4** [2], 86–91 (1930).—In the analysis of mineral oil ash from Maracaibo, Venezuela, the vanadium was determined gravimetrically with $HgNO_3$ and volumetrically with $KMnO_4$. The analysis gave a high content of vanadium (45.38%). E.J.V.

BOOKS AND BULLETINS

Potash. (Das Kali.) Vol. I. ERNST FULDA AND PAUL KRISCHE. Vol. II. ERNST FULDA, OTTO KRULL, PAUL KRISCHE, AND WILLY GROOP. Published by Ferdinand Enke, Stuttgart. *Z. oesterr. chem. Ztg.*, **33** [7], 60 (1930).—These volumes deal with the recovery, uses, and value of potassium salts and the chemistry and geology of their deposits. This is a comprehensive work which includes a summary of most of the papers written on the subject. L.T.B.

Pyrolusite and Its Uses. (Der Braunstein und seine Anwendung.) Ed. DONATH AND H. LEOPOLD. Published by Ferdinand Enke, Stuttgart. 2.80 M. *Z. oesterr. chem. Ztg.*, **33** [5], 43 (1930). L.T.B.

Useful Rocks of Germany and Their Deposits, with the Exception of Coals, Ores, and Salts. (Die nutzbare Gesteine Deutschlands und ihre Lagerstätten, mit Ausnahme des Kohlen, Erz und Salze.) W. DIENEMANN AND O. BURRE. **Vol. II. Solid Rocks.** W. AHRENS, O. BURRE, W. DIENEMANN, AND F. MICHELS. Ferdinand Enke, Stuttgart, 1930. 45 illustrations, 20 tables. Rm 33. Reviewed in *Sprechsaal*, **63** [18], 338 (1930); for abstract see *Ceram. Abs.*, **9** [7], 575 (1930). M.V.K.

Physiographical Evolution of Britain. L. J. WILLS. viii + 376 pp. Edward Arnold, London, 1930. Price one guinea. Reviewed in *Times Lit. Supp.*, Feb. 6, 1930. H.H.S.

Use of Cambrian clay in abrasive industry. K. KÖHLER. *Trans. Ceram. Research Inst.* [Moscow], **23,** 46 pp. (1929).—Researches were made on the Cambrian clays of Djetskoe Sselo (U.S.S.R.) and the Silesian abrasive clays and comparisons were made. The mechanical analysis of both clays included the determination of plasticity, water, drying and total shrinkage, absorption of water, and the mechanical strength of raw and fired specimens at different temperatures. The fusing point of the Cambrian clay was at cone 5, and that of the abrasive clay at cone 2 to 3. Special tests showed that an addition of 4% of $CaCO_3$ to the Cambrian clay lowers its fusing temperature to cone 2. The properties of the batches prepared from both clays were similar. It can be said that Cambrian clay has a greater plasticity, and an increased mechanical solidity of the vitrified batch. An abrasive material was added and the paste fired at different temperatures. The abrasive disks prepared from the batch of clays of Djetskoe Sselo, and fired at 1200°, showed an almost equal porosity, but a considerably higher mechanical solidity than those prepared from the Silesian abrasive clays fired at 1300°. See also *Ceram. Abs.*, **9** [7], 574 (1930), article by P. A. Zemiatchensky. M.V.K.

Geological sketch of Tschassoff-Jar refractory clays. P. A. ZEMIATCHENSKY. *Trans. Ceram. Research Inst.* [Moscow], **20,** 22 pp. (1929).—The deposits of refractory clays at Tschassoff-Jar (U.S.S.R.) contain sand, iron-hydroxide, loewigite, and alumite. The clay stratum is 2 m. thick and covers an area of 5 sq. km.; the weight of the clay per cu. m. is 1.5 T. The total supply is reckoned at 15 million T. See also *Ceram. Abs.*, **9** [7], 575 (1930), articles by K. Köhler and W. Isküll. M.V.K.

Chemistry and Physics

Ternary system zinc oxide–zinc chloride–water. HAROLD CECIL HOLLAND. *Jour. Chem. Soc.*, 643–48 (April, 1930).—Equilibria existing in the three-component system zinc oxide–zinc chloride–water at 25° and 50° have been studied and the compositions of the stable phases determined. Evidence has been obtained for the existence of two new oxychlorides of Zn, *viz.*, $ZnCl_2$, ZnO, $2H_2O$ and $ZnCl_2$, 5ZnO, $8H_2O$; and only one of those formerly described, *viz.*, $ZnCl_2$, 5ZnO, $8H_2O$ exists in stable equilibrium in the range of concentrations used. The same series of solid phases was found at 25° as at 50°.
E.C.C.

Modified method for decomposing aluminous silicates for chemical analysis. A. N. FINN AND J. F. KLEKOTKA. Bur. Stand., *Jour. Research*, **4** [6], 809–13 (1930); for abstract see *Ceram. Abs.*, **9** [3], 168 (1930). R.A.H.

Physical chemistry of potash-bearing silicates. ANON. *Pit and Quarry*, **20** [3], 56 (1930); for abstract see *Ceram. Abs.*, **9** [6], 470 (1930). E.P.R.

Reaction between ferric oxide and silica. J. ARVID HEDVALL AND PER SJÖMAN. *Svensk Kem. Tids.*, **42**, 40–42 (1930).—Fe_2O_3 from the oxalate and SiO_2 from quartz were finely ground and mixed in an agate mortar and then heated in an electric oven at 550 to 1350° in O_2 at atmospheric pressure. At about 575°, Fe_2O_3 combined with SiO_2 1:1 to about 2% of the total SiO_2. The reaction is advanced by increase of time, temperature, and SiO_2. One of the products of the series gave a spectrophotograph identical with that of cristobalite. (*C.A.*)

Analysis of green chrome oxide. S. R. SCHOLES. *Glass Ind.*, **11** [6], 137 (1930).—Chromium oxide because of its refractory, insoluble character, presents analytical difficulties. The methods given in textbooks for getting this material into solution are unsatisfactory and also destructive to platinum crucibles. The method described here in detail consists of a low-temperature fusion with sodium nitrate and sodium hydroxide, separation of chromate as barium chromate, and titration with potassium iodide and thiosulphate in acid solution. E.J.V.

Separation of barium from lead as the sulphate by means of ammonium acetate. I. MAJDEL. *Arhiv za Hemiju i Farmaciju*, **4** [2], 76–78 (1930).—In the presence of barium the separation of lead from barium by the precipitation of both components with H_2SO_4 and the solution of the $PbSO_4$ in ammonium acetate is not possible as the double salt $Pb(SO_4)_2Ba$ is formed. The salt is insoluble in ammonium acetate, therefore a part of the lead remains with the barium and the greater the masses the more barium is present in proportion to the lead. With ratios of Pb:Ba as 1:0.6 9% of the lead, 1:1 45% of the lead, 1:2 88% of the lead and with the ratio of 1:7 or more all of the lead adheres to the barium, whereby it is naturally lost. On these grounds the separation of lead from barium must be done by means of H_2S. E.J.V.

Dehydration of analytical precipitates. W. MIEHR, P. KOCH, AND J. KRATZERT. *Z. angew Chem.*, **43** [12], 250–54 (1930).—In analyzing for Al_2O_3 by the ammonia method, one obtains results which differ from those obtained by other methods. These differences are due to uncertainty in determining the Al_2O_3 as oxide rather than in the method, *i.e.*, faulty precipitation. To fully dehydrate Al-hydroxide a temperature of at least 1200°C is necessary. That temperature is not readily obtained in commercial laboratories and errors are introduced. Between 1200° and 1300° there is still a small loss in weight; above 1300° there is no loss. The dehydrated oxide is hygroscopic even over P_2O_5 if dehydration takes place at 1200°. At 1300° it is completely changed to corundum and is no longer hygroscopic. Hygroscopicity is a measure of reactivity of Al_2O_3; it may be detected by means of alizarine. At 1200° there is a slight reaction with alizarine as shown by the red color; similarly at 1350°. Only above 1450° there is no reaction. X-rays showed a normal corundum pattern when the precipitates were heated

at 1100° for two hours. At 1100° for one hour there were still some other lines. This is important in ceramics. An alumina raw material only loses its last water at 1450°C or at approximately its softening temperature. The porous structure of many calcined clays may be due to this last trace of water which is only driven off at high temperatures. If electric furnace corundum of the same fineness were used a denser body would result. In determining Al_2O_3 if it is heated to at least 1200° the results will not be more than 0.8% too high. Contamination by SiO_2 is negligible. If Al_2O_3 is determined by the phosphate method the precipitate contains 1% water if heated over a blast. It should be heated between 1200° and 1300°, but not above 1300°, for at that temperature it begins to lose P_2O_5. In determining SiO_2 precipitation errors are far greater than those introduced by residual water. A good blast is sufficient to drive off the water. At 1000° tridymite begins to form; silica at this temperature does not take up water readily. L.T.B.

Quantum mechanics of an electron or other particle. E. H. KENNARD. *Jour. Frank. Inst.*, **207** [1], 47–78 (1929).—K. gives an account of the changes in physical conceptions resulting from recent advances in quantum theory, and indicates how the principle phenomena have been handled in the new quantum mechanics. A comprehensive discussion is given of Heisenberg's Indetermination Principle. M.A.B.

Comparison of protons and electrons in the excitation of X-rays by impact. H. A. BARTON. *Jour. Frank. Inst.*, **209** [1], 1–19 (1930).—A mass spectrograph is used to bring either protons or electrons, of same energy in the range from 15 kv. to 25 kv., onto a copper target. The procedure was to compare two currents: (1) the current composing an electron beam just intense enough to produce detectable X-rays; and (2) that composing the strongest proton beam which produced less radiation. The ratio of these currents is a minimum value for ρ, the ratio of the efficiencies for excitation of electrons and protons respectively; ρ is of the order of magnitude 10^6. The results offer the possibility of checking the wave mechanics of impact processes. M.A.B.

Scattering of a standing electromagnetic wave. MILDRED ALLEN. *Jour. Frank. Inst.*, **207** [1], 19–45 (1929).—The observed scattering of a running electromagnetic wave by an electron (Compton effect) has been explained by use of Schrödinger's wave mechanics. This paper gives a theoretical treatment of the case of scattering by an electron of a standing electromagnetic wave, which may be considered as the sum of two running waves in opposite directions. The general conclusion drawn is that the scattering by the standing wave is the same as if the two oppositely directed component waves were scattered independently of each other. M.A.B.

Voltage-intensity relations of 29 lines of the mercury spectrum. P. B. TAYLOR. *Jour. Frank. Inst.*, **207** [1], 95–106 (1929).—T. records measurements obtained by the photographic method he used to investigate the 29 most prominent lines in the arc spectrum between 2378 and 4108, with the exception of the region about 2537 where the absorption of 2537 and the attendant bands complicate measurement. Photographs were taken with a quartz spectrograph with various voltages applied to the mercury arc, and the densities measured with a densitometer. Tables and curves are given to express the results clearly. M.A.B.

Correlations between photographic characteristics in the normal and in the solarized regions of exposures. A. P. H. TRIVELLI AND E. C. JENSEN. *Jour. Frank. Inst.*, **209** [1], 37–81 (1930).—A statistical investigation was made for the determination of correlations between different photographic characteristics in the normal exposure region, at the maximum density, and in the first reversal of the solarization from fourteen different commercial photographic emulsions. The regression theory of solarization is in better agreement with the correlations found than is the coagulation theory. M.A.B.

Absorptive power for liquids and porosity of ceramic bodies. I. J. ANDRE LAVERGNE. *Rev. mat. constr. trav. pub.*, No. 246, pp. 49–51B (1930).—Methods of determination and calculation are given. **II.** *Ibid.*, No. 247, pp. 69–72B (1930).—Methods and calculations are continued. Experimental data on many ceramic materials are given. See also *Ceram. Abs.*, **9** [6], 474 (1930). A.J.M.

Contribution to the study of drying of clays and of clay bodies. II. V. BODIN AND P. GAILLARD. *Rev. mat. constr. trav. pub.*, No. 246, pp. 45–49B (1930).—The description of French clays is continued. A table of chemical analyses of the clays is given. Data are presented on the drying shrinkage and on the porosity of the dried products. **III.** *Ibid.*, No. 247, pp. 65–69B (1930).—A complete description of a test drier is given. Graphs show the drying characteristics of the clays tested. For Part I see *Ceram. Abs.*, **9** [6], 472 (1930). A.J.M.

Angle of floating lenses. CHARLES GEORGE LYONS. *Jour. Chem. Soc.*, 623–35 (April, 1930).—The shapes and angles of liquid lenses floating on the surface of a different liquid have been studied by a photomicrographic method. The angles are subject to wide variations and are especially sensitive to alterations in the interfacial tension between two liquids. It has been shown further that these angles differ from those calculated on the basis of Neumann's triangle and the causes of the differences have been investigated. The contact angles at a junction of three liquids have been investigated with reference to the theory of emulsification. It has been suggested that emulsification by soap may be determined by existence of a bimolecular soap leaflet at the oil-water interface. E.C.C.

Cataphoretic measurements and the theory of the critical potential. D. R. BRIGGS. *Jour. Phys. Chem.*, **34** [6], 1326–52 (1930).—The mechanism of coagulation of hydrophobic sols is discussed, special attention being given to the exceptional behavior of the large majority of negatively charged sols with salts of monovalent cations. The results show consistently that the cataphoretic velocity is reduced at the concentration of total precipitation by the highly absorbed monovalent cation salts to a value which coincides with that which is general for polyvalent cation salts at their respective coagulation concentrations. This proves that the monovalent ions act just as the polyvalent ions in their effect upon the value of the cataphoretic velocity; both reduce the charge, *i.e.*, to the same value at their coagulation concentrations when adsorption of the ions of opposite charge to that of the colloid takes place to such an extent that no very large concentration of electrolyte is needed to bring about precipitation. In the case where large concentrations of electrolyte are required to precipitate the sol, some secondary effect brings about precipitation before the charge, *i.e.*, is reduced to that value exhibited with other salts. The manner in which the electric charge functions as a stabilizing factor is described. G.R.S.

Thermodynamic considerations of some interesting reactions. I. BRICHTA. *Arhiv za Hemiju i Farmaciju*, **3** [3], 106–13 (1929).—The Nernst theorem is applied to some reactions, principally of organic chemistry. E.J.V.

Thermodynamics of high pressures. V. NJEGOVAN. *Arhiv za Hemiju i Farmaciju*, **4** [2], 49–61 (1930). E.J.V.

Quantitative determination of small amounts of free or organically combined carbon in inorganic substances. DRAGUTIN STROHAL. *Arhiv za Hemiju i Farmaciju*, **3** [2], 63–72 (1929). E.J.V.

New modification of the gravimetric determination of the phosphoric ion as $Mg_2P_2O_7$. N. KRILENKO. *Arhiv za Hemiju i Farmaciju*, **2** [4], 197–205 (1928). E.J.V.

Faija-Dietrich apparatus. ANON. *Tonind.-Ztg.*, **54** [29], 493 (1930).—The Faija-Dietrich apparatus for the determination of carbonic acid is distinguished from other apparatus of this kind, Scheibler, Dietrich-Frühling, and others, in that the outside air

pressure need not be taken into consideration. Temperature is simply and easily measured. M.V.K.

Specific heat zero point and specific heat. I. MAJDEL. *Arhiv za Hemiju i Farmaciju*, **3** [3], 93–105 (1929).—Heat vibrations present only one of the many possible kinds of energy which are expressible in different vibratory movements. According to the classification of Crookes, the heat vibr tions are those vibrations which are found in the boundaries of the 45th and 48th octaves (from 35 to 281 billion vibrations per second). The energy of some vibrations can be converted into the energy of other vibrations through known ratios in the same way as heat and electrical and mechanical energy are converted from one to another. By lowering the temperatures of the body and by the lowering the frequency of heat vibration, it is possible to reach the limit of heat vibrations. That temperature (T_0) at which the above-mentioned state results and the body no longer possesses any heat vibration is called the "specific heat zero point." Such a state in the body is characterized by the condition that the true specific, atomic, and molecular heat of the body must be zero. The study of the functional relationship between the true atomic heat (μ) and the temperature (t) has led to the conclusion that for all elements in the solid state

$$\mu = \gamma - \frac{\alpha}{t + \beta} \qquad (1)$$

where α = constant = 939.8 and γ and β are the characteristic parameters for each element. On widening the validity of formula (1) in the direction of lower temperatures it is seen that $\mu = 0$, when

$$\gamma = \frac{\alpha}{T_0 + \beta} \quad \text{or} \quad T_0 = \frac{\alpha}{\gamma} - \beta \qquad (2)$$

It is clear that this temperature T_0 is the "specific heat zero point." It is assumed that every body has its own specific heat zero point, whose position can be determined by use of formula (2). Periodicity of T_0, of γ and β, the construction of M.'s classification of the elements from that of Goldschmidt, the erection of Dulong-Petit's laws from his formulas are strong arguments for the correctness of M.'s ideas. E.J.V.

Heat of evaporation of water and specific volume of saturated vapor for temperatures up to 210°. M. JAKOB. *Z. Ver. deut. Ing.*, **73,** 504 (1929); *Sci. Abs.*, **32B,** 380, 433; see also *Ceram. Abs.*, **9** [5], 389 (1930). (*C.A.*)

International temperature scale between 0° and 100°. J. A. HALL. *Trans. Roy. Soc.* [London], **A229,** 1–48 (1930).—The Seventh General Conference of Weights and Measures, in Sept., 1927, in defining the International Temperature Scale, recognized the thermodynamic centigrade scale as the "fundamental scale to which all temperature measurements should ultimately be referable," and specified a scale based on fixed points, with standard means of interpolation, as the best conveniently realizable approximation. For the interval between 0° and 660°, it specified that the scale shall be defined by a Pt resistance thermometer, with the formula $R_t = R_0 (1 + At + Bt^2)$, the constants R_0, A, and B, being determined by calibration at the ice, steam, and S points. The temperature of S boiling at 760 mm. pressure is defined as 444.60°. The International Temperature Scale therefore eliminates the Hg thermometer as a standard means of interpolation. It is thus necessary to determine what change adoption of the Pt resistance thermometer makes in a temperature scale based on Hg in "verre dur" thermometers. This was done at the National Physical Lab. (England) for the interval 0° to 100°, the scale there in use being based on the Hg thermometers which were originally calibrated against the constant volume H thermometer at the International Bureau at

Sèvres. It was found that for the individual thermometers, among the 15 examined, differences as great as 0.02° were observed; but that the change from the Hg to the Pt resistance thermometric scale will not entail a change of more than 0.002° between 0° and 50°, nor of more than 0.005° between 50° and 100°. No difference between the thermodynamic scale and that defined by the Pt thermometer was detected, the Hg in "verre dur" thermometers being used as an intermediary. (*C.A.*)

Measurement of thermal expansion. HANS GERDIEN AND WERNER JUBITZ. *Wiss. Veröffentlich. Siemens-Konzern*, **8**, 218-27 (1929); for abstract see *Ceram Abs.*, **9** [6], 445 (1930). (*C.A.*)

BOOKS

Conductivity of Solutions. CECIL W. DAVIES. Chapman and Hall, Ltd., London. 195 pp. Price $4.00. Reviewed in *Can. Chem. Met.*, **14** [5], 96 (1930).—This book is, in one sense, a critical examination of data and work already reported from the standpoint of recent developments. In a general way it is a text and a history describing methods of operation of leading research workers. Data and comment are well presented and arranged, so that the subject is developed in a thorough, descriptive, laboratory, and mathematical manner. E.J.V.

Developments in the Potash Industry. (Fortschritte in der Kaliindustrie.) C. HERMANN. Published by Theodor Steinkopff, Dresden and Leipzig. *Z. oesterr. chem. Ztg.*, **33** [6], 51 (1930).—This book is especially good for its description of the apparatus for solution, crystallization, and separation of potassium salts. It is a valuable book for anyone interested in solution and crystallization technique. L.T.B.

Men Who Found Out; Stories of Great Scientific Discoverers. MRS. AMABEL WILLIAMS-ELLIS. Coward-McCann, Inc., New York. 259 pp. (*C.A.*)

PATENTS

Artificial plagioclase compound. FELIX SINGER. U. S. 1,759,919, May 27, 1930. A process of manufacturing artificial plagioclase compounds which consists in heating oxycompounds of bivalent metals and oxycompounds of silicon and of alumina in a proportion substantially corresponding to the formula $RO \cdot Al_2O_3 \cdot 2SiO_2$ to temperatures approximating but not reaching the point of fusion of the mixtures obtained.

Production of alkaline-earth titanates. REGINALD HILL MONK AND LUDVIG FIRING. U. S. 1,760,513, May 27, 1930. A process of producing a titanate of barium from precipitated titanium hydrate which comprises treating the hydrate with sodium acetate to unite with all the SO_4 in the hydrate, washing with water to remove the sodium sulphate formed, adding to the hydrate barium carbonate and adding a sufficient amount of HCl to form an accelerator and heating the mixture to approximately 830°C.

Production of chromates with simultaneous recovery of alumina. HEINRICH SPECKETER AND GEORG HENSCHEL. U. S. 1,760,788, May 27, 1930. The process of producing sodium chromate with simultaneous recovery of alumina, which comprises the steps of subjecting a mixture of a chrome ore and bauxite with the amount of soda ash required for forming chromates, aluminates, and ferrates in an oxidizing atmosphere to a temperature of about 900° to 1000°C, extracting the hot mass with water to produce a solution of about 1.26 specific gravity, keeping the solution at a temperature of at least 100°C until the separation of the silicic acid in form of sodium-aluminium silicate is completed, filtering off the solution, precipitating the alumina from the latter by carbonic acid, filtering off the sodium carbonate and chromate solution, concentrating the same until the main quantity of sodium carbonate is separated, filtering off the chromate solution and separating the chromate therefrom.

Producing titanium oxide. RALPH M. PALMER. U. S. 1,760,992, June 3, 1930. In the herein described process, the steps of subjecting the residue from a digestion

process for recovering the aluminum content of bauxite to wet concentration to separate iron oxide, ferro-titanium oxide, and titanium oxide therefrom, magnetically separating titanium oxide from the ferro-titanium oxide and iron oxide, and magnetically separating the ferro-titanium oxide from the iron oxide.

Manganese compound recovery. NAPOLEON ARTHUR LAURY. U. S. 1,761,133, June 3, 1930. A process of recovering manganese values from ore containing manganese dioxide which comprises converting manganese dioxide to manganous oxide, leaching manganous oxide from the ore with a solution capable of dissolving the manganous oxide and incapable of dissolving other material of the ore, the solution being characterized by an acid content sufficient to neutralize the basicity of the manganous oxide dissolved, separating the solution from the other material, and recovering manganese values from the solution.

Titanium compounds. TITANIUM PIGMENT CO., INC. Fr. 672,002, March 25, 1929. Ti compounds are precipitated in a very fine state by adding organic acids, *e.g.*, oxalic acid, to a solution containing Ti and an inorganic acid, such as H_2SO_4, at a temperature of about 90°. Fr. 672,003 describes a similar process in which a mixture of an organic acid and phosphoric acid or a compound thereof are added to the solution. (*C.A.*)

Complex silicates. FELIX SINGER. Ger. 486,218, Dec. 18, 1926. Masses resembling plagioclase are prepared by heating a mixture of the approximate formula $RO{\cdot}Al_2O_3{\cdot}2SiO_2$ in which R is Mg, Ca, Sr, Ba, Zn, or Fe, to a temperature 50° or so below the fusion temperature. The fusion temperature is defined as the softening point of a cone of the Seger type. The initial materials for the mixture may be the carbonates, sulphates, silicates of Mg, etc., Al silicate, etc. An example is given. (*C.A.*)

Complex silicates. FELIX SINGER. Ger. 487,724, Nov. 25, 1928. Addn. to 486,218. The method of Ger. 486,218 (see preceding patent) is modified by starting from a mixture of the approximate composition $2RO{\cdot}2Al_2O_3{\cdot}5SiO_2$, and by including in the mixture a compound containing the OH group, *e.g.*, Mg $(OH)_2$ or $Ca(OH)_2$. Products of the cordierite group are also obtained. (*C.A.*)

Titanium compounds from ores. I. G. FARBENIND. A.-G. Ger. 490,600, March 12, 1926. Ti ores are treated at high temperature with dilute H_2SO_4 in the presence of reducing agents, preferably compounds of tervalent Ti compounds. Thus, ilmenite, containing approximately 55% TiO_2 and 33% Fe, is heated with 40% H_2SO_4 and Cu to 180° for 6 hrs. On lixiviating the matrix, H_2TiO_3 with about a 0.5% Fe content is obtained. Without the reducing agent, the Fe content is about 20%. Other examples are given. (*C.A.*)

Titanium compounds. I. G. FARBENIND. A.-G. Can. 285,355, Dec. 4, 1928. Ti compounds are manufactured by working up ilmenite with strong or fuming H_2SO_4 acid, dissolving the strongly acid material in water with the addition of a suitable quantity of K_2SO_4, isolating the double sulphate thus obtainable, and hydrolyzing. *E.g.*, 1000 parts of strongly acid material obtainable by working up ilmenite with H_2SO_4, which contains $Ti(SO_4)_2$ in a quantity equivalent to about 17% TiO_2, is quickly heated with 2500 parts of water and 400 parts of K_2SO_4 to 95°. The solution is filtered while hot. In the cold, *i.e.*, at about 0 to 5°, the double sulphate separates in about 65 to 75% the quantity calculated on the dissolved Ti. The greatest part of the rest of the double salt may be isolated by evaporating. (*C.A.*)

General

Exploring clay deposits by drilling. V. W. BOEKER. *Brick Clay Rec.*, **76** [11], 700–703 (1930).—The terms, "prospecting" and "exploring" are explained. A thorough drilling of a deposit will give three facts: (1) The quantity of material present may be accurately computed from the area and the thickness of the strata; (2) the quality of

the material and its adaptability to specific uses may be determined by physical and chemical tests of the samples removed; (3) the question of minability can be answered by a study of the physical distribution of the material, its dip, and the amount of overburden present. The diameter of the holes to be drilled depends on the amount of information that is expected from such holes. The number of holes required to explore a deposit thoroughly varies and the spacing of the drill holes depends entirely upon the thoroughness required and upon the amount of variation in structure encountered. A system developed by B. is explained in detail. Illustrated. See also *Ceram. Abs.*, **9** [7], 527 (1930). E.J.V

Cause of objects breaking after third firing. L. BINI. *Le Industrie dei Silicati; Corriere ceram.*, **11** [4], 153–57 (1930).—The frequent breaking of objects after the third firing is due to too rapid firing. The surface of the objects already fired twice is nonporous which makes necessary a very slow third firing to permit the heat to penetrate the interior gradually and expand all molecular layers simultaneously. M.V.K.

Open and closed pores in ceramic ware. W. MIEHR, H. IMMKE, AND J. KRATZERT. *Ceram. Age*, **14** [1], 4–5 (1929); for abstract see *Ceram. Abs.*, **8** [9], 670 (1929). W.W.M.

Rationalizing a brickworks. ANON. *Brit. Clayworker*, **39** [457], 50–52 (1930).—The article discusses the following items as applied to the manufacture of brick: (1) planning production, (2) controlling production, (3) controlling cost, (4) planning and control of buying, (5) planning deliveries, (6) investigation and research, (7) markets and sales, (8) the personnel, (9) the rationalization of finance, and (9) elimination and vitalization. R.A.H.

Applying the Bedeaux system in industries. M. SPAGNOLI. *Corriere ceram.*, **11** [4], 163–67(1930).—The principle points of the Bedeaux system of rationalizing an industry are explained. (1) This system establishes a rational method of measuring the quantity of work done by a normal man at normal velocity in a Bedeaux unit of time, which includes a proportionate fraction of time for a rest period and varies according to the nature of the effort. The Bedeaux system examines with precision the movements, both necessary and sufficient to accomplish a given piece of work and measures the time required to perform it at normal velocity, normal velocity meaning a direct movement with least possible deviation and without strain. (2) The Bedeaux system establishes a rational system of compensation for work done, differentiating between superior and inferior workmen. (3) A rational system for controlling the output is fixed. A long series of repetitions with a system of chromometrology are used to determine the standards. Among the many advantages of the Bedeaux system are elimination of controversy, stimulating the workman by competition, and contribution toward regulating the prices of the finished product. M.V.K.

Practical examples of industrial management of men. A. FRIEDRICH. *Glastech. Ber.*, **7** [11], 489–97 (1930); *Diamant*, **51** [35], 682 (1929).—Management of labor is the backbone of all rationalization. The proper supervision and guidance of labor must be worked out clearly. Specific points in the proper handling of labor are pointed out, using practical examples as illustrations. E.J.V.

Eliminate broken ware and extra handling. ANON. *Brick Clay Rec.*, **76** [10], 629–42 (1930).—It is pointed out how the elimination of damage claims on clay products railroad shipments would result in great cost reduction. The various branches of the clay products industry are all developing and the market is increasing. In order to reduce costs there should be an elimination of handling of the ware, and also some method of car loading should be used which would prevent some of the damage now being inflicted on clay products in shipment. A method of handling which would reduce the handling to a minimum and do away with some of the damage is outlined.

Several different methods of packing and loading ware now being experimented with are discussed. Illustrated. E.J.V.

Ideas for use in plant practice. H. L. LONGENECKER. *Brick Clay Rec.*, **76** [11], 697–99 (1930).—These include fireproofing wooden pallets and decks by saturating them with a saturated solution of sodium silicate; use of a device known as a bull-wheel instead of a winding drum; use of a revolving core on the end of a brick machine auger shaft to overcome lamination; making of a toothed-roll crusher from an old disintegrator; use of replaceable scoring plates in a hollow-building tile die; manufacture of hollow brick by use of a hollow-tile die on the brick machine with an end cutter; and a method of figuring kiln band riveting to secure maximum strength. Illustrated. E.J.V.

Dutch view of the American brick industry. ANON. *Klei*, **22** [2], 13–18; *Tonind.-Ztg.*, **54** [11], 187 (1930).—A Dutchman visiting several brick plants in Pa. and Ohio found both modern and unimproved working methods, but the quality of the brick produced was first class. A description of the plants visited is given. M.V.K.

Production of china and employment. W. GRAHAM. *Pottery Gaz.*, **55** [636], 996 (1930).—Particulars supplied by the English China Mfrs. Assn., relating to the numbers employed by firms claimed to be responsible for 50 to 60% of the output of these products, showed an increase in 1928 of 1.3%, and in 1929, 5.5%, over the numbers employed in 1927. E.J.V.

Borax ore preparation in Death Valley. H. L. GLAZE. *Chem. Met. Eng.*, **37** [5], 296–98 (1930).—Ore treated consisted of colemanite and ulexite. The ore mixed with country rock was dumped directly into bins and was later given two reductions, first in a gyratory crusher and then in a set of rolls. Crushed ore was fed into calcining furnaces. During calcination colemanite lost its water of crystallization and fell into a powder, but the ulexite was little acted upon by the heat (approximately 900°F) and was discharged still in its original lump form. The mixed product was separated into "flour borax" and tailings. Reverse concentration was necessary in treating the tailings, as ulexite is lighter than the shale. Pneumatic classifiers were used, resulting in substantial saving in labor costs, and also eliminating pumping and storage of water. G.R.S.

Predetermination of daylighting by the fenestra method. W. C. RANDALL AND A. J. MARTIN. *Trans. Illum. Eng. Soc.*, **25** [3], 262–81 (1930).—A method is presented of designing for daylighting based on theory and data carefully correlated and clarified so that it can be readily and accurately used by the architect and engineer. Curves and tables of a standardized daylight prediction are presented. M.A.B.

Calculation of daylighting and indirect artificial lighting by protractor method. H. H. HIGBIE AND W. TURNER-SZYMANOWSKI. *Trans. Illum. Eng. Soc.*, **25** [3], 213–61 (1930).—Calculations of the illumination by light admitted through windows are made by measuring the angles subtended by the windows or by the reflecting surfaces at the point where one wishes to know the illumination, and referring to the charts in this paper. Decrease of illumination due to obstructions of any kind, such as mullions, piers, columns, and wall thickness around window openings, may be calculated by treating them as surface sources having zero brightness if their reflection coefficient is small. The protractor method is also applicable to artificial lighting. M.A.B.

Value of the economizer in present-day boiler installations. G. E. TANSLEY. *Colliery Guardian*, **140** [3618], 1658–59 (1930).—T. discusses the value of economizers from the standpoints of such factors as (1) higher boiler pressures; (2) higher boiler outlet-gas temperatures; (3) higher permissible economizer water-outlet temperatures; (4) longer economizer life due to higher feed-inlet temperatures; and (5) increased gas velocities, which mean (*a*) increased economizer efficiencies, (*b*) in-

creased cleanliness, (*c*) reduction in capital outlay for a given duty, and (*d*) longer life of machine. E.J.V.

Study value of slag as filter medium in sewage-disposal plants. ANON. *Pit and Quarry*, **20** [4], 33–34 (1930).—The field investigation, in conjunction with sodium sulphate tests on samples collected from existing beds, shows that crushed blast-furnace slag is a durable material when employed as a sewage filtering medium. E.P.R.

Drying brick. K. O. SCHULZ. *Tonind.-Ztg.*, **54** [34], 575–77 (1930).—According to investigations, the degree of evaporation of the moisture contained in clay depends on the following factors: (1) steam tension of the material; (2) steam tension of the air; (3) velocity of the air moving over the surface of the material; and (4) physical properties of the material. The degree of evaporation depends on the porous structure much more than on the volume of pores and the degree of the loss of moisture in a clay is almost directly proportional to the size of the surface per unit of weight of the dried clay under uniform conditions. Improper drying produces (1) warping of ware; (2) breaking; (3) coarse fissures; (4) cracks; (5) internal tensions; and (6) network of surface cracks. Warping and breaking are caused by unequal drying and shrinkage. Bursting can be ascribed to bad preparation of the raw paste which may also cause the formation of bubbles in clays of high plasticity. The network of fine surface cracks appears especially on wares molded very damp and can be avoided only by regulation of the moisture content and movement of the air. Such cracks appear also on ware covered by an engobe too quickly dried. In drying a wet surface at constant temperature the degree of evaporation increases in almost equal proportion to the velocity of the air moving over the surface of the ware (this should be about 3 m./sec.). M.V.K.

Decrease poisonous gas fumes following blasts. ANON. *Pit and Quarry*, **20** [5], 78 (1930).—One of the most important improvements in du Pont high explosives during the past year was a reformulation of Red Cross extra dynamite which reduces the poisonous gases given off by this explosive to a volume no greater than that produced by the present du Pont gelatin dynamites. E.P.R.

Treating roads with silicates. ANON. *Industrie chimique; Giorn. chim. ind. applicata*, **12** [3], 149–50 (1930).—Tests were made during the past year for treating roads with silicates. The mechanics of the action of silicates on a calcareous stone is not the formation of calcium silicate but is a phenomenon of crystallization and hardening due to the silica being liberated, which increases the resistance of materials and assures a better bond between the elements of the pavement. The Servizio dei Pontie Strade forsees the use of a silicate treatment for roads in regions where paving materials are of mediocre quality and transportation is high. M.V.K.

Big brick apartments moved. ANON. *Bldg. Econ.*, **5** [6], 18 (1929).—Well-built brick buildings are as stable and easy to handle as are their counterparts in frame construction. There is an adhesive strength in a brick wall and it will withstand tremendous strain before cracking. If the proper materials are used, the brick shell becomes almost as strong as if it were metal. E.P.R.

Pottery exports from France. LOUIS DESMARQUEST. *Pottery Gaz.*, **55** [634], 661–62 (1930); abstracted from *La Céramique*.—A review of French pottery exports for the years 1927, 1928, and 1929. Markets for this ware are discussed. E.J.V.

Is this a "piker" Society? EDITORIAL. *Bull. Amer. Ceram. Soc.*, **9** [6], 177–78 (1930).—While crediting the SOCIETY with the progress made, it is pointed out that it is not keeping pace with its opportunities. It must step forward more decisively. E.J.V.

Society of Glass Technology. ANON. *Pottery Gaz.*, **55** [636], 957–61 (1930); *Glass Ind.*, **11** [6], 131 (1930); for abstract see *Bull. Amer. Ceram. Soc.*, **9** [6], 209–10 (1930). E.J.V.

Glass Container Association Meeting. ANON. *Glass Ind.*, **11** [6], 148 (1930).—A brief report of the annual meeting held at Atlantic City, April 30 to May 2, 1930. Some of the topics spoken on are listed, as are the newly elected officers of the Association. E.J.V.

Ohio Association reviews its work. ANON. *Brick Clay Rec.*, **76** [11], 712–14 (1930).—For detailed account see *Bull. Amer. Ceram. Soc.*, **9** [7], 223 (1930). E.J.V.

Common Brick Manufacturers Association. ANON. *Brick Clay Rec.*, **76** [10], 643–46 (1930).—The Common Brick Mfrs. Assn. is one of the foremost trade bodies in the U.S. and the strongest association in the clay products industry. It has made progress in promoting common brick and has taken an initiative in matters of importance to the common brick industry. Many of its efforts have also effected improved conditions for other branches of the clay industry. This article presents a brief history of its beginning, its accomplishments, and activities. Illustrated. E.J.V.

Wedgwood Bicentenary celebrations. ANON. *Pottery Gaz.*, **55** [636], 977–92 (1930); see also *Ceram. Abs.*, **9** [7], 591 (1930). E.J.V.

Brick in artistic displays. ANON. *Bldg. Econ.*, **5** [8], 2 (1929).—The Brick Mfrs. Assn., Philadelphia district, has an elaborate brick display in the state. Brick façades in various types of bonds, laid with natural and colored mortars to produce the most harmonious effects with the varicolored brick are shown, as well as samples of patternwork, skintled brickwork, and all of the modern developments in first-class masonry. E.P.R.

New glost kiln for Homer Laughlin China Co. ANON. *Clay-Worker*, **93** [5], 350 (1930).—A new 200 Harrop glost kiln is being erected at No. 4 plant, Newell, W. Va., to replace six upright kilns. E.J.V.

New silicate plant for California. ANON. *Chem. Met. Eng.*, **37** [5], 327 (1930).—The Philadelphia Quartz Company of Calif. has purchased $12^1/_2$ acres of land at South Gate on which to erect a plant. G.R.S.

New plant. ANON. *Ceram. Ind.*, **14** [6], 648–58 (1930).—An illustrated description of the new enameling plant and processes of the George D. Roper Corp., Rockford, Ill. W.W.M.

Italian glass news. ANON. *Nat. Glass Budget*, **46** [3], 12 (1930).—Italian glass industry production has been reduced but it is still too large, and stocks in the factories are growing. E.P.R.

Mexican machine window glass plant. ANON. *Nat. Glass Budget*, **46** [6], 23 (1930).—The first machine-equipped window glass plant ever erected in Mexico is probably now in operation. At present the equipment consists of three Fourcault machines. A place has been provided on the tank for the fourth machine when the demand warrants. The factory is located at Monterey. Natural gas will be used as a fuel. E.P.R.

History of Belgian glassmaking. ANON. *Rev. belge ind. verrières*, **1**, 52 (1930). A.J.M.

Future of the Belgian window glass industry. ANON. *Rev. belge ind. verrières*, **1**, 53 (1930). A.J.M.

Cement industry in Italy and chemistry of cement. SESTINI. *Giorn. chim. ind. applicata*, **12** [2], 101–102 (1930).—In his lecture at Bergamo, S. traces the progress of the cement industry in Italy from 1856. At present there are about 150 plants in Italy representing a capital of more than a billion lire. Approximately 600 kilns are in operation with 25,000 employees; the production capacity is about 38 million quintals of cement per year; actual production averages 35 million quintals (1929), 60 to 65% of which is natural Portland, and 30 to 35% artificial; 2 million quintals blast-

furnace cement; 800,000 quintals pozzuolana; 50,000 quintals fused cement. In his second lecture S. discusses the chemistry of cement showing slides of the internal structure of different cements and the stages of hardening. M.V.K.

Report of the meeting of the Union of German Portland Cement Manufacturers. ANON. *Tonind.-Ztg.*, **54** [25], 424–25; [26], 446–49; [27], 460–64 (1930).—The following reports were read: (1) Haegerman, "The vitrifying of Portland cement raw paste"; (2) Eitel, "The hydrate of tricalcium aluminates"; (3) W. A. Roth, "Methods of investigating the thermochemistry of cements"; (4) H. Kühl, "Influence of the fine-grained structure on the solidity properties of Portland cements"; (5) F. Krauss, "Observations on complex combinations and their significance in regard to the structure of substances in Portland cement"; (6) Burhartz, "The practical value of the combined storing"; (7) R. Nacken, "Determination of heat of formation of silicates from their oxides"; (8) Lennart Forsen, "The chemical action of gypsum and other agents retarding the setting time of Portland cement clinker"; (9) O. Graf, "Protecting concrete against corrosive waters"; (10) A. Hummel, "The working out of sieve analyses and the Abrams modulus of fineness"; (11) A. B. Helbig, "Improvements in cement mills." M.V.K.

Italian glass market. ANON. *Pottery Gaz.*, **55** [636], 998 (1930); reprinted from *Rivista Industrie dei Silicati;* see also *Ceram. Abs.*, **9** [6], 482 (1930). E.J.V.

Glass news of Sweden. ANON. *Nat. Glass Budget*, **46** [3], 12 (1930).—Production and sales in the glass bottle industry in Sweden increased during 1929, and no foreign competition was met with. E.P.R.

German plate glass. ANON. *Pottery Gaz.*, **55** [636], 997 (1930).—The "outsiders" in the plate glass business, along with a number of important dealers in Rhineland-Westfalia, have made an agreement for the sale of plate glass which is said to be one of a year's duration to deal with a supply of several thousand square meters per month. Efforts are to be made to bring about some kind of understanding. E.J.V.

German glass industry. ANON. *Pottery Gaz.*, **55** [636], 997–98 (1930).—According to the business report of the Union of German Medicine Glass Factories, 1929 was a most critical year for the industry. There is a smaller demand for bottles. A combination of adverse causes may lead to a general reduction of production. E.J.V.

Re-equipment of Russian glassworks. ANON. *Pottery Gaz.*, **55** [636], 997 (1930).—The re-equipment of the Constantinovsk factory has been begun with the installation of a Fourcault machine. When this is completed the production of the factory will be doubled. This factory will produce glass for motor car requirements. E.J.V.

Safety glass production in Germany. ANON. *Pottery Gaz.*, **55** [636], 997 (1930).—The Union of German Plate Glass Factories has begun the production of safety glass in its Herzogenrath factory, near Aachen. E.J.V.

Riga glassworks slow down. ANON. *Pottery Gaz.*, **55** [636], 997 (1930).—Four Riga glassworks, employing 700 hands, which depend on government orders, have to go on short time; some may have to close down. E.J.V.

Belgian window glass news. ANON. *Nat. Glass Budget*, **46** [3], 11 (1930).—The Belgian plate glass industry is undergoing a great change in both operating and selling fields. E.P.R.

Exportation of Italian ceramic products to America. ANON. *Rassegna Commerciale; Corriere ceram.*, **11** [4], 149–53 (1930).—Observations on the present American market for Italian ceramic products include the facts relating to the possibility of increasing the clientele and keeping up and developing the demand by a study of the tastes and needs of the American public, a consideration of the competitive exportation from other European and Asiatic countries, and the necessity of organized distribution through American importing firms in the largest American cities, or foreign

representatives of American firms in Italy, or through department store buyers. The practical American favors utility combined with beauty, simplicity rather than excessive ornamentation. Preferred articles are lamps, vases, decorative and mural plates, pitchers, tea and table service (especially the featured rustic or "peasant majolica" table service), "open work" in majolica of all types and designs, the so-called "graphite" reproduction of ceramic pieces found in excavations, and antique or Raphaelesque reproductions. M.V.K.

"Pushing" British pottery and glassware in Canada. S. A. REYNOLDS. *Pottery Gaz.*, **55** [636], 963 (1930).—R. goes outside his own business as a china and glass specialist to expound the merits of British ware. E.J.V.

British pottery in Canada. ANON. *Pottery Gaz.*, **55** [636], 962–63 (1930).—An excerpt of the speech made by the Dominion Minister of Finance, announcing preferential treatment for many British commodities, and additions to the free list of tableware of British china, presenting data on imports of ceramic materials and products, is given. E.J.V.

Polish electrical porcelain. ANON. *Pottery Gaz.*, **55** [636], 951 (1930).—Production of electrotechnical material in Poland has been of little consequence, and its few factories do not yet supply the inland demand, but the production is rapidly increasing. Almost all the raw material is found in the country, except china clay. E.J.V.

Italian fireproof ware. ANON. *Pottery Gaz.*, **55** [636], 937 (1930).—The fireproofware industry last year had only 75% of its normal production, a large proportion of which had to go into stock. A preference was shown by Italian consumers for foreign goods, and there was a considerable increase in the importation of medium-class goods. There was a marked decline in the exportation of fine goods. E.J.V.

Ancient Chinese pagoda. ANON. *Bldg. Econ.*, **5** [9], 12 (1929).—The earliest Chinese history proves clayworking even before 2700 B.C. to have been an art. China's porcelains, dating centuries back, are by far her most outstanding accomplishment in the finer ceramic arts. A leaning pagoda, standing in the province of Tonkin, in French Indo-China is built of brick of the characteristic Chinese type, large, thick, and overlong, fired to a surprising density. Originally it was plastered with a thick coat of mortar which has fallen off in spots, leaving the brick exposed. The structure is well preserved. E.P.R.

Commercial Standard Classifications adopted by feldspar producers. ANON. *Pit and Quarry*, **20** [3], 55–56 (1930); for abstract see *Ceram. Abs.*, **9** [4], 290 (1930). E.P.R.

Recent German research on cement. C. R. PLATZMANN. *Rock Prod.*, **33** [11], 92–94 (1930).—A review by P. of the reports of the general meeting of the German Portland Cement Mfrs. Assn. W.W.M.

Brick industry in Argentine. HANS BYCZKOWSKI. *Tonind.-Ztg.*, **54** [35], 591–93 (1930).—The brick industry in Argentina is developing very rapidly and the production is about 15 to 20 millions per year. The most modern and important plant is the "Fabrica Ceramica Alberdi bei Rosario" on the Rio Parana. It uses three kinds of raw materials: (1) La Plata earth, (2) slip clay used as ball clay, and (3) humus which is very pure. A detailed description of the plant is given. M.V.K.

Shortage of building materials in Russia. ANON. *Econ. Rev. Soviet Union*, **5** [2], 42 (1930).—The great increase in the building program in Russia (1928 to 1929) caused a shortage of building materials; 9% in the production of brick and 7% shortage in cement. M.V.K.

Magnitogorsk steel mill. ANON. *Econ. Rev. Soviet Union*, **4** [23], 417–19 (1929).—Among the large steel plants under construction in Russia, the Magnitogorsk plant is well located near the great iron deposits of Magnet mountain in the Troitzk

district of the Ural region. In the immediate vicinity of the ore deposits are large deposits of limestones, dolomite, refractory and red clay, sand, and building stone, all of which are required for the industrial processes and the construction of the plants. The plant will have the following departments: coking, with a chemical plant for by-products; furnace, steel foundry (Martin-Siemens, Bessemer); rolling; casting; mechanical; repair and boiler; forge; electromechanical; red and refractory brick; sawmill and woodworking; power station; laboratories; and warehouses. M.V.K.

Industrial enterprises in U.S.S.R. ANON. *Econ. Rev. Soviet Union*, **4** [16–17], 280–84 (1930).—Among the industrial enterprises under construction in Russia are listed a glass factory, a cement factory, and refractory material factories at Konstantinovka. M.V.K.

New glass and cement factories in U.S.S.R. ANON. *Econ. Rev. Soviet Union*, **5** [1], 18 (1930).—The new Gussevo glassworks, among the largest in Europe, will have a production of 400,000 cases of glass a year at lower production costs than that of the old factories. A large cement plant just begun in the Ural region will produce 700,000 barrels of cement per year. M.V.K.

Cement plant in Maastricht. ANON. *Centraalblad Bouwbedrivek*, **21** [39], 307–309; *Tonind.-Ztg.*, **54** [30], 521 (1930).—Description of the working of raw materials and the manufacturing process of the first Holland cement industry "Enci" in Maastricht. M.V.K.

New cement plant near Newied. ERICH AUERBACH. *Tonind.-Ztg.*, **54** [6], 87–91 (1930); *Rock Prod.*, **33** [7], 83 (1930).—This new plant on the Rhein near Newied, Germany, belongs to the "Wicking werke" and has a production of 470,000 T. of cement per year. The mills, silos, and kilns are of unusual size. The mills have a diameter of 2.2 m. and are 14 m. in length. The four elutriating silos are 20 m. high, their base is made of Portland cement of high quality, and the tank is made of alumina cement. The six cement silos are of the same size and have a capacity of 1400 T. each. An electric suspension trolley is used to load the bags of cement on ships. This plant has the newest devices for an efficient operation and is the most modern cement plant in Germany. M.V.K.

Portland cement mill to be established in ancient city of Damascus. ANON. *Pit and Quarry*, **19** [3], 113 (1929).—A letter from Chick Sadi Ketabi of Damascus, Syria, explains the plans of a company, of which he is vice-president, for erecting, in his city, a modern Portland cement factory. This new company bears the French title Société Nationale du Ciment et des Materiaux de Construction and was organized last February. E.P.R.

Cement firms in France combine. ANON. *Pit and Quarry*, **20** [5], 22 (1930).—A powerful cement combination was recently formed through the absorption of the Société Anonyme des Ciments d'Allas et de Marnac, the Société des Chaux et Ciments de l'Ariege, and the Union Commerciale et Industrielle du Languedoc, by the Société des Chaux et Ciments du Languedoc, Paris, France, which has increased its capital by issuing $1,170,000 in new shares. The Allas and Marnac firm showed net profits of $95,614 last year and Ariege firm netted $30,907 during the same period. E.P.R.

PATENT

Furnaces for burning powdered fuel. CLARKE, CHAPMAN, & CO., LTD., AND W. A. WOODESON. Brit. 323,484; *Colliery Guardian*, **140** [3618], 1701 (1930).—The furnace tube of the boiler has a two-part extension, completed by a front. This front is provided with a clearing door and, above it, a burner inclined so that flame coming therefrom can impinge upon a portion of a brickwork lining. This portion is inclined so that slag will flow toward the door instead of onto the tube plate. The burner employed may be of any suitable kind. Baffles retard the velocity and cause the flame

to spread and the initial supply of coal dust and primary air is caused to issue through a Venturi nozzle, which has the effect of bringing the air and dust into intimate contact and increasing the velocity to an extent to ensure it passing the baffles and coming into contact with the brickwork in order to create and maintain the desired hot spot. The brickwork may be of any convenient length. The angle at which the burner is inclined is decided by the velocity of the entering stream of coal and air together with the chimney draft and the natural tendency for the flame to rise. E.J.V.

BOOKS, BULLETINS, AND CIRCULARS

Aluminum Industry. EDWARDS, FRARY, AND JEFFRIES. 2 volumes. McGraw-Hill Book Co., Inc., New York. Price per set, $12.00. Reviewed in *Can. Chem. Met.*, **14** [5], 96 (1930).—Volume I, "Aluminum and Its Production," covers the development of the industry, the ores of aluminum and their mining and refining, and the production of the metallic product. The production of alumina has been treated in considerable detail, and the various methods proposed and in use are discussed. The general story of the metal is well told, insofar as developments in America are concerned; and there is a special chapter devoted to the growth of the industry in Europe. In general, Volume II, "Aluminum Products and Their Fabrication," treats the properties of aluminum and its alloys and the manufacture of aluminum products for industry. The result is a very complete presentation of scientific data and manufacturing practice. E.J.V.

Trade Associations, Their Services to Industry. JOSEPH HENRY FROTH. 338 pp. 5 1/2 x 8 1/2 in. Published by Ronald Press Co. *Abrasive Ind.*, **11** [6], 38 (1930).—This manual analyzes the necessity for constructive and productive leadership by trade associations in the fields of market research, trade extension, quality standardization, scientific research, legislation, self-regulation within the industry, service, etc. E.P.R.

Mechanical World Year Book. ANON. 180 pp. 4 x 6 in. Published by Emmott & Co. Ltd., Manchester, England. *Abrasive Ind.*, **11** [6], 38 (1930).—This annual publication for engineers has been brought to date by several improvements and new sections have been added. Sections on steam engines, steam turbines, condensers, and rope drive have been revised and rewritten. E.P.R.

Volunteer Portland Cement Co. ANON. *Pit and Quarry*, **20** [5], 80 (1930).—This company has issued a bulletin of 8 pp. and 7 illustrations describing the methods of manufacturing regular and high early-strength Portland cements. E.P.R.

Making and Firing Glazed Ware. H. ANSELL AND A. B. SEARLE. Reviewed in *Brick Clay Rec.*, **76** [10], 664 (1930); for abstract see *Ceram. Abs.*, **9** [7], 593 (1930). E.J.V.

Complete Tunnel-Kiln Plant. ANON. *Pit and Quarry*, **20** [5], 80 (1930).—A. P. Green Fire Brick Co. has issued a booklet of 24 pp., 42 ill., describing and illustrating the new firebrick plant of this company at Mexico, Mo. E.P.R.

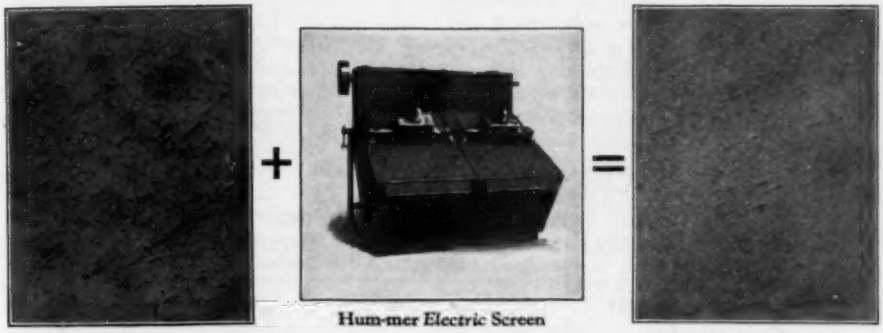
Index to British Standard Specifications. ANON. *Mech. World*, **87** [2252], 199 (1930).—The 1930 edition of the Index to British Standard Specifications is a complete subject index which, in view of the large number of Brit. Stand. Specif., will be of much assistance to those purchasing engineering and allied material apparatus. A numerical list of the specifications is also included. Copies are available from the Publications Dept., British Engineering Standards Assn., London. E.P.R.

Pocket Book for Ceramists. ANON. *Ceram. Ind.*, **14** [6], 658 (1930); for abstract see *Ceram. Abs.*, **9** [5], 396 (1930). W.W.M.

BOOK REVIEW

Annual Survey of American Chemistry. Volume IV. Edited by CLARENCE J. WEST. 549 pp. Published for National Research Council by Chemical Catalog Co.,

Inc., New York, N. Y. Price $4.00. A review of the progress made in pure and applied chemistry for a period of eighteen months beginning July 1, 1928, and ending December 31, 1929, is presented in forty-three chapters by fifty-one contributing editors, each an authority on the subject he writes about. This concise, accurate survey serves to keep the chemist informed of the general directions in which progress is being made in the various departments of chemical science and industry, and to point the way for a more exhaustive reading in fields in which he is especially interested. The chapter on Ceramic Products is by E. Ward Tillotson and R. F. Ferguson, and there are several other chapters that are of interest to the ceramic engineer who is keeping up with latest developments in his field of endeavor. E.J.V.



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Hum-mer *Electric* Screen

Section of brick made from Hum-mer-screened clay

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Ceramic Educational Directory

THE OHIO STATE UNIVERSITY

Department of Ceramic Engineering, COLUMBUS, OHIO

Curriculum—Ceramic engineering and technology. Advanced research in co-operation with State owned plants and Federal Government

SIX INSTRUCTORS *Head of Department:* ARTHUR S. WATTS
Founded 1895 *Research Professor:* GEORGE A. BOLE

NEW YORK STATE SCHOOL OF CLAYWORKING AND CERAMICS

ALFRED UNIVERSITY, ALFRED, NEW YORK

Curriculum—Ceramic Engineering, Ceramic Chemistry, Applied Art

NINE INSTRUCTORS *Founded 1900* *Director:* CHARLES F. BINNS

RUTGERS UNIVERSITY

NEW BRUNSWICK, N. J.

Ceramic Department founded 1902

Curriculum—Ceramic Technology and Engineering

THREE INSTRUCTORS *Director:* GEORGE H. BROWN

UNIVERSITY OF ILLINOIS

Department of Ceramic Engineering *Founded 1905* URBANA, ILLINOIS

Curriculum—Ceramic Engineering and Ceramics, the latter is a non-engineering course in the technology of ceramic products

SIX INSTRUCTORS and a research associate *Head of Department:* C. W. PARMELEE

IOWA STATE COLLEGE

Department of Ceramic Engineering, AMES, IOWA

Curriculum—Ceramic Engineering major, Ceramic Technology and ornamental ceramics

FOUR INSTRUCTORS, TWO COURSES *Founded 1906* *Head of Department:* PAUL E. COX

THE UNIVERSITY OF NORTH DAKOTA

Department of Ceramics and Ceramic Engineering, GRAND FORKS, N. D.

Curriculum—Ceramic Art and Technology

FIVE INSTRUCTORS *Founded 1910* *Director:* A. W. GAUGER

UNIVERSITY OF WASHINGTON

Department of Ceramic Engineering, SEATTLE, WASHINGTON

Curriculum—General ceramic engineering with research in ceramics and non-metallics

Coöperation with the U. S. Bureau of Mines

Director: HEWITT WILSON *Founded 1918* *Assistant:* J. H. YATES

UNIVERSITY OF SASKATCHEWAN

SASKATOON, SASK.

Curriculum—Ceramic Engineering

TWO INSTRUCTORS *Founded 1921* *Head of Department:* W. G. WORCESTER

PENNSYLVANIA STATE COLLEGE

Department of Ceramics, School of Mines and Metallurgy

STATE COLLEGE, PENNA.

Curriculum—Ceramic Engineering

Head of Department: J. B. SHAW *Founded 1923*

GEORGIA SCHOOL OF TECHNOLOGY

ATLANTA, GEORGIA

CERAMIC DEPARTMENT *Curriculum*—Ceramic Technology and Engineering

TWO INSTRUCTORS *Founded 1923* *Director:* A. V. HENRY

VIRGINIA POLYTECHNIC INSTITUTE

BLACKSBURG, VIRGINIA

Curriculum—Ceramic Engineering

Founded 1929 *Head of Department:* J. W. WHITTEMORE

NORTH CAROLINA STATE COLLEGE OF AGRICULTURE AND ENGINEERING

RALEIGH, NORTH CAROLINA

Department of Ceramic Engineering founded 1923 — *Curriculum*—Ceramic Engineering
THREE INSTRUCTORS — *Head of Department:* A. F. GREAVES-WALKER

WEST VIRGINIA UNIVERSITY

MORGANTOWN, W. VA.

Ceramic option course founded 1924

Curriculum—Chemical and engineering principles applied to ceramic manufacture
TWO INSTRUCTORS AND TWO ASSISTANTS — *Director:* W. A. KOEHLER

UNIVERSITY OF TORONTO

TORONTO, CANADA

Founded: University, 1827; Department of Metallurgy, Ceramic Division, 1925

Curriculum—Ceramic Engineering and Technology
TWO INSTRUCTORS — *Principal Instructor:* ROBERT J. MONTGOMERY

MISSOURI SCHOOL OF MINES AND METALLURGY

OF THE UNIVERSITY OF MISSOURI, ROLLA, MO.

Curriculum—Ceramic Technology and Ceramic Engineering

TWO INSTRUCTORS

Director: CHAS. H. FULTON — *Founded 1926* — *Head of Department:* M. E. HOLMES

UNIVERSITY OF CINCINNATI

CINCINNATI, OHIO

Dept. School of Applied Art, Ceramic Dept.

Curriculum—Coöperative training in ceramic art and technology to develop designers for ceramic industries

Founded 1926 — *Head of Department:* HAROLD S. NASH

THE OHIO STATE UNIVERSITY

Department of Fine Arts, COLUMBUS, OHIO

Curriculum—Ceramic art and technology to train artists for the ceramic industries
THIRTEEN INSTRUCTORS — *Head of Department:* JAMES R. HOPKINS
Founded 1927 — *Professor of Ceramic Art:* ARTHUR E. BAGGS

UNIVERSITY OF OKLAHOMA

NORMAN, OKLAHOMA

Dept. of Ceramics, School of Fine Arts — *Curriculum—Ceramic Art*
Founded 1927 — *Head of Department:* JOHN N. FRANK

UNIVERSITY OF ALABAMA

UNIVERSITY, ALABAMA

Ceramic Option Course, Founded 1928

Curriculum—Technical ceramic courses given by Dept. of Chemistry and Metallurgy
TWO INSTRUCTORS — *Director:* STEWART J. LLOYD *Ceramics:* T. N. MCVAY

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CAMBRIDGE, MASS.

Curriculum—Graduate Study and Research in Ceramics
FIVE INSTRUCTORS — *Founded 1929* — *Head of Course:* F. H. NORTON

LOUISIANA STATE UNIVERSITY AND AGRICULTURAL AND MECHANICAL COLLEGE

BATON ROUGE, LA.

Curriculum—Optional Courses now given by the Department of Geology
THREE INSTRUCTORS — *Ceramics Dept. founded 1925* — *Head of Dept.:* H. V. HOWE

STANFORD UNIVERSITY

Department of Mining Engineering, STANFORD UNIVERSITY, CALIFORNIA

Curriculum: Two-year graduate course in ceramic engineering, offering various combinations with mining and metallurgical engineering. Research in ceramics and non-metallics.
Director: THEODORE J. HOOVER — *Founded 1925* — *Professor in charge:* W. F. DIETRICH

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BULLETIN

of the

AMERICAN CERAMIC SOCIETY

A Monthly Publication Devoted to Proceedings of the Society, Discussions of Plant Problems, Discussions of Technical, Scientific, and Art Questions, and Promotion of Coöperative Research

Edited by the Secretary of the Society Assisted by Officers of the Industrial Divisions

E. DEF. CURTIS, MYRTLE M. FRENCH, ERWIN SOHN, W. N. HARRISON	Art, Enamel	J. T. LITTLETON, A. N. FINN, C. F. GEIGER, DOROTHY A. TEXTER, R. F. SHERWOOD, E. H. FRITZ	Glass, Refractories, White Wares	H. D. CALLAHAN, L. A. DOUGHERTY, HOWELLS FRÉCHETTE, W. H. VAUGHAN	Terra Cotta, Heavy Clay Products

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Vol. 9 **August, 1930** **No. 8**

EDITORIALS

MEMBERSHIP SUPPORT

Members are absolute necessities to the life of any organization. They simply must be had.

Although this SOCIETY does show a steady growth in members, yet the ceramic manufacturers are not supporting it anywhere nearly as much as they should. The membership analysis for 1928 and 1929 and for the first six months of 1930 is given as follows:

MEMBERSHIP STATEMENT

1928

Memberships	Status January 1	New Members	Gross Totals	Resignations	Cut-Offs	Net Total Jan. 1, 1929
Personal	2191	222	2413	62	84	2267
Corporation	309	16	325	14		311
Honorary	9	5	14			14
Life	2	2	4			4
	2511	245	2756	76	84	2596

1929

						Net Total Jan. 1, 1930
Personal	2267	240	2507	105	43	2359
Corporation	311	15	326	20		306
Honorary	14		14			14
Life	4		4			4
	2596	255	2851	125	43	2683

1930
(For six months (Jan. to July 1))

	Status January 1	New Members	Gross Totals	Resignations	Cut-Offs	Net Total July 1, 1929
Personal	2359	217	2576	66	36	2474
Corporation	306	4	310	16		294
Honorary	14		14			14
Life	4		4			4
	2683	221	2904	82	36	2786

There are many individuals, not members of this SOCIETY, engaged in ceramics who are profiting from the reports of original investigations and from the abstracts of the world's literature of interest to ceramists which the members of this SOCIETY compile and exchange. They should be sharing in this compilation and in the cost of this coöperative work. They would profit more largely if they were participating.

"He profits most who serves best."

Firms producing ceramic ware, equipment, and materials have profited greatly from the coöperation of the members of this SOCIETY. The privately-owned trade press reflects the advances made in the ceramic arts, science, and technology; it has been a powerful factor in these advancements. The ceramic trade associations have been engaged in technological researches on the production, the quality, and the use of the products made by their respective members. Producing concerns have increased their technical personnel and are increasingly engaging in technical investigations of their own problems. Other scientific and technical societies, universities, institutes, bureaus, and surveys have, to an increasing extent, engaged in ceramic investigations. The literature is growing in amount and in value both in fundamental and applied information. Ceramic societies in each of the industrial countries abroad have been organized since this SOCIETY was founded and ceramic institutes established. State organizations are being established to secure ceramic research under state supervision and by state financing. The number of schools offering instructional courses in ceramics and engaging in ceramic investigations is increasing.

The effect of these increased educational and investigational activities with special emphasis on ceramics is perfectly obvious. The cause of this increased activity is the need for more fundamental and applied information.

The fact is that ceramic ware production, once "on top" from every viewpoint, got so far behind other products in every way technically that ceramic manufacturing was headed for an economic slump even when business generally was good.

Higher and higher wages had to be paid; better quality ware had to be produced; factory methods and equipment had to be improved; mass production was required; all of which stimulated the application of the

physical and chemical sciences to the problems of lower cost of producing higher quality ware and maintaining a standing in a highly competitive market.

There is no denying all of the industrial advances which have been made in ceramics and there is no denying the increase in amount of ceramic investigations which have been started. Ceramic manufacturing concerns have, to a considerable extent, successfully met the issues arising from the demands for higher wages and better product quality.

The fact remains, however, that producers of products which can substitute for ceramic products have made greater and more rapid strides in lowering their production costs, improving their product quality, and in capturing the markets.

More steam ahead in the promotion of the ceramic arts, science, and technology must be the slogan for producers of clay, glass, and enameled ware. More individual and concerted effort must be made to lower costs, improve quality, and to prove serviceability of our ceramic products.

There must be a larger participation in the coöperative activities of the chemical, mechanical, electrical, mining, and special product societies and institutes which would prosecute studies of silicate mixtures and uses of ceramic products.

There must be a larger coöperation with our universities and governmental bureaus to obtain the share due ceramics of the money and research facilities spent by these agencies. Other industries are getting more than their share because they are organized to obtain it.

Graduates of the scientific and engineering schools should be ceramic minded. It is no credit to the ceramic industries that architectural and engineering graduates are trained to construct with all sorts of materials more than with ceramic products, or that our domestic science graduates should not know the superior excellence of ceramic table and kitchen ware. A closer coöperation with the universities would yield more applied and fundamental researches and would make the oncoming men and women of affairs more conscious of ceramic ware.

Art and museum schools everywhere in America are training youths to create things of beauty and service. An increasing number of them is engaging in ceramic craft work; very few in applied ceramic art. The ceramic industries and the art schools would profit largely by mutual cultivation. That such collaboration has yielded profits in Sweden, Norway, Germany, England, and elsewhere is well known. American ceramic industrialists should collectively work closer with our art schools.

When we take stock of the industrial progress made and of the increases in agencies that are engaged in promoting the ceramic arts, sciences, and technology we take pride in the advances which have been made. But when we compare our total net gains with the net gains made by other

industries we find many reasons for a more aggressive promotion of the ceramic arts, sciences, and technology. Compared with achievements and technological activities in other industrial lines, ceramic manufacturers find no reason for being satisfied and every reason for giving support to every agency engaged in improving the arts, sciences, and technology of ceramic ware production and use.

The AMERICAN CERAMIC SOCIETY has for thirty-two years been a co-operative organization of ceramic persons and firms. It is growing in strength to accomplish its work. It has changed in body and in activities with the changes in opportunities to accomplish this same work.

This SOCIETY has proved itself worthy, by accomplishments, to be given larger facilities with which to act. It is not now able to meet the opportunities to serve the ceramic industries because of shortage of finances and lack of personal and corporation support.

Every ceramic corporation and firm would be making a much needed and a very profitable investment for themselves if they would support this SOCIETY as a corporation member paying twenty-five dollars annually.

Will you secure these corporation members?

DEPRECIATION DOES NOT PAY

For accounting purposes it is often profitable to depreciate to current values on the private books the money equivalent of plant and stock. Values on plant and equipment are regularly depreciated to offset upkeep and replacement costs. These depreciations on book values on material things are in line with sound business principles.

The firm which most severely depreciates on its private books its material assets would resist most vigorously any depreciation of its business integrity, and good will.

Appreciation of integrity, appreciation of capacity to perform an agreed service, and appreciation of good-will are absolutely essential to the business and social well-being of individuals and organizations.

Society (civil, social, and business) is so dependent on the well-being of its individual constituent members—men—that depreciation of any person makes a subtraction from the well-being of each member of the society.

It pays to appreciate, even to over-estimate, the excellences of our fellow-men. Business slumps are caused and are prolonged by depreciations, not in material things, but in mutual confidences.

Coöperative affairs are even more sensitive to depreciatory influences. No business organization can withstand the weakening influence of calumnious depreciation of its organization personnel.

Good-will appreciation pays. Ill-will depreciation costs very heavily.

Appreciate yourself by appreciating each of your fellows. By the same token, resist depreciations of yourself and of your fellows. It pays to promote mutual appreciation vigorously: it pays to contend vigorously against depreciation.

Appreciation of self cannot be reached through depreciation of others.

When ceramic people come to an appreciation and understanding of their fellow ceramic persons, firms, and products, there will result larger profits and greater well-being.

Brick of each sort, structural tile, and terra cotta, each has its particular value for constructional purposes. The producer of one material, who attempts depreciation of the others, depreciates his own product.

Glass and china each has its own service and appeal. In reality they are not competitors. If the china and the glassware producers would mutually appreciate in their sales talk both china and glass tableware there would be more business for both; both will always be purchased and attempts of depreciation by either is futile.

There is need for more unanimity in boosting each other; each ceramist boosting, never knocking his fellow ceramist; each firm boosting those making a like product; each association pulling in accord with the other associations.

The face brick manufacturers by acts committed and omitted have done more to limit the sales of face brick than have the acts of producers of the so-called competitive products. This holds true with the producers of each ceramic product.

Greater success, well-being, and happiness are going to be obtained when in business and personal relations there is given full recognition of the fact that each is his greatest competitor and that nothing whatsoever is gained for self by depreciation of others.

OUR JOURNAL ADVERTISEMENTS

That it pays to advertise is a proven fact. Equally well proven is the fact that it pays to advertise only where the advertising message will be read.

It is idle to expect firms to expend money monthly without receiving returns. Advertising is not a good-will gesture.

Advertising space is provided in the *Journal of the American Ceramic Society* for two basic reasons: (*a*) strictly business and (*b*) to accelerate technical advances.

At no time has it been contemplated that the advertising income would pay the publishing and editorial expense of the *Journal*. Never has the

advertising income equaled the printing bills. This is as it should be. The *Journal* is not published for direct financial profit.

The *Journal* is used by the members of the SOCIETY as a means for exchanging and recording original investigations, committee reports, and abstracts of the world's literature of value to ceramists. The *Journal* is restricted in number of pages of printed matter issued each month only by the amount of money available to pay the cost, a large part of which is paid from membership dues.

The strictly business feature of advertisements in the *Journal* is the returns which the advertisers realize. They have good reasons to argue that the *Journal* belongs to the members and the members who are in the various ceramic industries and laboratories make recommendations and decisions regarding equipment and materials purchased. Advertisements in the *Journal* will, therefore, carry their messages to those who have a two-fold interest, first, in obtaining the best equipment and materials, and second, in making more effective their means (the *Journal*) of information exchange. The advertisers are justified in the belief that for these two reasons the members have a proprietary interest in the *Journal* advertisements.

The SOCIETY does not employ an advertising representative to make personal solicitations. Such advertising as has appeared in the *Journal* has been secured by general solicitations and through individual member interests. The fact that the amount of advertising has averaged for each of the past five years over twenty-eight paid pages per month, exclusive of classified and exchange advertisements, shows a sustained confidence in the efficacy of advertising in this *Journal*.

Since it is of importance to the welfare of and progress in ceramics that the members have the greatest possible opportunity to exchange reports of researches, to abstract the ceramic literature, to publish bibliographies, book lists, and other research aids, the *Journal* of this SOCIETY is an ally, rather than a competitor with the privately owned ceramic journals in securing as much advertising for this *Journal* as is possible.

There is no lack of real concern for the financial success of the privately-owned trade journals in an appeal for advertisements for the *Journal of the American Ceramic Society*. But this appeal must be made by the individual members. It is the business of the members of this SOCIETY singly and collectively to present the opportunities of advertising space in the *Journal* to those firms which are not at present in the *Journal*. The members also should let it be known to those firms which are advertising that their messages are being read. This duty and responsibility rests with the members.

ACTIVITIES OF THE SOCIETY

AMERICAN CERAMIC CONGRESS, CLEVELAND AUDITORIUM

February 22 to 28, 1931

Headquarters Announcement

The week of February 22, 1931, is the time, Cleveland, the city, and the Auditorium, the place for all the meetings and the Exposition.

Because of the large attendance, three hotels have been selected for the residential headquarters and for Divisional breakfasts and dinners.

Hotel Cleveland will house members of the Heavy Clay Products Divisions and the American Refractories Institute Division.

The Statler Hotel will be home for the Art, Terra Cotta, and White Wares Divisions.

The Hotel Hollenden will be the place of abode for the Enamel and Glass Divisions.

It is none too early to make your room reservations.

The Cleveland Committee is planning informal entertainment for the ladies and will sponsor one general "get together" occasion, but there will be no formal banquet.

There will be social occasions by Divisions and schools. A novel and far from dull time for each member has been planned.

The Divisional programs are well under way and the Exposition is already an assured success. Thirty-three exhibitors have made partial payments for booth spaces and several others have merely the question of location to decide before finally signing contracts.

This American Ceramic Congress is going to be the best antidote for the slow times now being experienced. Information and advertising values in this Congress for every American concern and person interested in ceramics will more than repay all that it will cost in time, effort, and money.

It behooves each ceramic firm and person to make plans now for attendance and for participation in the meetings and Exposition.

Reduced Fares on Certificate Plan: New Scheme

The members of the AMERICAN CERAMIC SOCIETY are offered a new plan for securing the usual one and one-half fare for round trip on the Identification Certificate Plan. The following communication from the Central Passenger Association outlines the plan presented:

Limit Time Round-trip tickets will be sold at one and one-half fare (with minimum of $1.00) for the round trip, on Identification Certificates, applicable only for members of your organization and dependent members of their families. Tickets will be good only via same route in both directions.

Children of 5 and under 12 years of age when accompanied by parent or guardian will, under like conditions, be charged one-half of the fare for adults.

Round-trip tickets will be sold from the above-mentioned territory from February 19 to 25, inclusive, and before being honored for return passage, return portions thereof must be validated (in space provided therefor) at Cleveland, Ohio, by ticket agents' dating stamp at the regular ticket offices of the lines over which tickets read into Cleveland from February 22 to March 6, inclusive, and when validated, tickets will be good for return, leaving on any day within final limit; passenger *must*, however, reach original starting point within transit limit shown on ticket, but in no case later than midnight of March 6, 1931.

Thirty-Day Stop-Over In addition, the carriers have authorized from the same territory as outlined above, one and three-fifths fare for the round trip on Identification Certificates, with return limit of thirty days from date of sale. Selling dates, namely Feburary 19 to 25, inclusive, and other conditions are the same as will apply in connection with the fare and one-half basis.

This arrangement is in addition to the one and one-half fare for the round trip authorized for your convention, and the identification certificates may be used in purchasing a round-trip ticket on either the bas'is of one and one-half fare *or* one and three-fifths fare. It will be necessary, however, for your members, when purchasing round-trip tickets, to indicate to ticket agents, which ticket is desired: namely, whether ticket at one and one-half fare with limit of March 6, 1931, or ticket at one and three-fifths fare with limit of thirty days from date of sale.

While the basis of one and three-fifths fare is slightly higher than the one and one-half fare basis, there may be a number of your members who would desire to avail themselves of the opportunity of obtaining the much longer limit of thirty days by paying the slight difference in fare.

We have notified the following Passenger Associations concerning the arrangement and requested them to advise you as soon as possible in the same relation covering their respective territories:

Trunk Line Assn. From New York State (east of and including Buffalo, Niagara Falls, Suspension Bridge, and Salamanca), New Jersey, Pennsylvania (east of and including Erie, Oil City, and Pittsburgh), Delaware, Maryland, District of Columbia, Virginia, and West Virginia (east of and including Wheeling, Parkersburg, Kenova, Orange, and Norfolk): C. M. Burt, Chairman, 143 Liberty St., New York, N. Y.

New England Passenger Assn. From New England States: F. VanUmmersen, Chairman, South Station, Boston, Mass.

Southeastern Passenger Assn. From territory south of Ohio and Potomac and east of Mississippi Rivers: W. H. Howard, Chairman, 101 Marietta St., Atlanta, Ga.

Western Passenger Assn. From territory west of Chicago, Peoria, and St. Louis and east of Washington, Oregon, and Nevada: T. Thompson, Chairman, 916 Transportation Bldg., Chicago, Ill.

Southwestern Passenger Assn. From territory southwest of St. Louis, including Texas, Arkansas, Oklahoma, Missouri (south of Missouri River) and Louisiana (west of Mississippi River): J. E. Hannegan, Chairman, 704 American Trust Building, St. Louis, Mo.

Trans-Continental Passenger Assn. From California, Nevada, Oregon, and Washington: E. L. Bevington, Chairman, 428 New Union Station, 516 W. Jackson Blvd., Chicago, Ill.

Canadian Passenger Assn. (Eastern Lines) From territory east of and including Armstrong, Fort William, and Sault Ste. Marie, Ont.: C. P. Riddell, Chairman, Room 905—263 St. James St., Montreal, Que.

Canadian Passenger Assn. (Western Lines) From territory west of Armstrong, Fort William, and Sault Ste. Marie, Ont.: Jos. B. Parker, Secretary, 320 Union Station, Winnipeg, Man.

A RECORD FOR THE JOURNAL AND ABSTRACTS

The *Journal* papers and abstracts have grown in number and value. Editorial means have been used with increasing severity to present them in the most concise

shape. In 1922, the printed material on each page was increased 27½%. The abstracts are no longer illustrated and each one is condensed to the minimum.

There is no way, adequately and concisely, to present the record for the past nine years except by number of pages. These are shown in this table.

NUMBER OF PAGES ISSUED

Year	Journal	Abstracts	Bulletin	Additional
1922	944	340	388	
1923	1310	322	406	Thirtieth anniversary of World's First Collegiate Ceramic School Ceramic Book List Report of Committee on Standards
1924	930	350	508	Silica and Magnesite Bibliography
1925	870	420	727	List of Books on Glass Bibliography on Scumming and Efflorescence Bibliography of Reports on Clay Deposits
1926	896	494	496	Bibliography and Monograph on Terra Cotta
1927	1028	718	388	Refractories Bibliography
1928	934	1024	396	Standards Report
1929	830	1100	380	Enamel Bibliography
1930 (7 months)	508	598	228	Art Division Symposium

This year the SOCIETY has an unusual wealth in original papers and the number of abstracts has increased steadily. The number of pages shown in the above table does not reveal the increase in number of papers and abstracts because of the increasing editorial condensing of both.

There is also nearly ready for publication (1) a large Ceramic Book List, (2) a Bibliography of Bibliographies of Ceramic Literature, and (3) Ceramic Calculation.

The Book List is being compiled by the several university libraries collaborating. This book list already comprises 52 pages of 8-point solid text. Proofs are being circulated for rechecking and additions by the university libraries.

The Bibliography of Bibliographies was compiled by Clarence J. West and D. D. Berolzheimer of the National Research Council. This is now being printed and will appear with the the Book List.

The Monograph on Ceramic Calculations was prepared by James T. Robson. The manuscript for this monograph is being prepared for the printer and should be issued in the early fall.

The White Wares Division has a bibliography on white wares in course of compilation. It has a rather complete bibliography presented by C. W. Parmelee of the University of Illinois which must be checked and supplemented. Those who can assist in this should communicate with L. Navias, General Electric Co., Schenectady, N. Y.

The Heavy Clay Products Division has two bibliographies, one on general topics which is being compiled by Frank Hartford of the Harrop Ceramic Service Company, and the other just getting under way on salt glazing.

The Geological Survey Committee, W. M. Weigel, Chairman, Hewitt Wilson, J. W. Whittemore, G. R. Shelton, and R. B. Ladoo, is compiling a geological bibliography.

F. P. Hall of the Onondaga Pottery Co. has compiled what has been said to be the most complete listing with illustrations of authentic phase-rule studies of silicate fusions. This has been released by the U. S. Bureau of Standards and will be published by the

Committee on Data, George A. Bole, Chairman. Dr. Hall reports that the manuscript will be completed and references checked ready for publication this Fall.

There is every material evidence that this will be a banner year for the SOCIETY. The members will have to boost the membership and the advertising incomes if they succeed in accomplishing this very ambitious and valuable production program.

NEW MEMBERS RECEIVED FROM JUNE 1 TO JULY 1

PERSONAL

Eugene A. Hults, Vice-President, Mathieson Alkali Works, Saltville, Va.
Frederick Laurence Nobes, Ceramic Chemist, The Carborundum Co., Ltd., Manchester, England.
Fred D. Reardon, 5585 Underwood, Detroit, Mich.; Foreman, Champion Porcelain Co., 8525 Butler Ave.

Membership Workers' Record

PERSONAL

G. A. Bole	1
Wm. B. Cleverly	1
Robert Twells	1
Total	3

ROSTER CHANGES IN JUNE

CORPORATION*

Libbey-Owens-Ford Glass Co., H. R. Black (voter), Nicholas Building, Toledo, Ohio. (Libbey Glass Mfg. Co.).
Northwestern Terra Cotta Co., B. Purcell (voter), 4417 Oleatha Ave., St. Louis, Mo. (R. F. Grady (voter)).

PERSONAL*

Allen, F. B., Secretary and Treasurer, Maryland Refractories Co., Dorsey, Md. (86 Market St., Perth Amboy, N. J.)
Beam, James R., Universal Sanitary Mfg. Co., New Castle, Pa. (Bucyrus, Ohio.)
Becker, Otto, New England Fuel and Transportation Co., Everett, Mass. (Hammond, Ind.)
Burr, Robert B., Southern Natural Gas Corp., Watts Bldg., Birmingham, Ala. (Columbus, Ohio.)
Christensen, John B., Jr., Seymour, Mo. (315 N. Coal St., Mexico, Mo.)
Galbraith, Robert, 222 Papin Ave., Webster Groves, Mo. (Crystal Lake, Ill.)
Gerster, C. W., 909 McKinnon Ave., East Liverpool, Ohio; Louthan Mfg. Co. (Columbus, Ohio.)
Gilmore, R. B., 19521 Shoreland Ave., Rocky River, Ohio. (1851 Lampson Rd., Cleveland, Ohio.)
Gregorius, Joseph S., Window Glass Research, Pittsburgh Plate Glass Co., Mt. Vernon, Ohio. (Creighton, Pa.)
Heisel, W. A., Chas. Taylor Sons Co., 18125 Northlawn Ave., Detroit, Mich. (Chicago, Ill.)
Hertzell, E. A., 3415 East St., N. S., Pittsburgh, Pa. (Univ. of Illinois, Urbana, Ill.)
Higgins, Waldo W., 1332 Oakland Ave., Milwaukee, Wis. (1116 W. Illinois, Urbana, Ill.)

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* Addresses within the parentheses ( ) represent the old address.

These roster changes which are published each month may be checked against the complete Membership Roster which was published in the July, 1929, issue of the *Bulletin*. Copies of this issue may be obtained from the Secretary's office, price $2.00.

Hodgdon, Frank B., Department of Physics, Massachusetts Institute of Technology, Cambridge, Mass. (Ames, Iowa.)
Hodgdon, Mary Y., No. 2 Myles Standish Apartments, 15 Linnaean St., Cambridge, Mass. (Mary L. Yancey, Ames, Iowa.)
Houser, Victor F., 3234 North Griffin, Los Angeles, Calif. (Whittier Terra Cotta Works, Whittier, Calif.)
Hughes, Thomas J., R. D. No. 5, Clayville, Pa. (573 South Main St., Washington, Pa.)
Humphrey, Ingraham, Carrolton, Ohio. (Lima, N. Y.)
Irving, Donald R., 1438 Poinsettia Place, Hollywood, Calif. (Burbank, Calif.)
Kempf, W. C., 66 College Ave., New Brunswick, N. J. (182 Jefferson St., Perth Amboy, N. J.)
Larkin, Paul G., 1107 Oak St., South Pasadena, Calif.; Pacific Clay Products, Plant No. 4, Los Angeles, Calif. (Spokane, Wash.)
McDonald, Earl F., Ingram-Richardson Mfg. Co., Beaver Falls, Pa. (651 E. Washington St., Frankfort, Ind.)
Meyer, F. R., 7683 Carswold Drive, Clayton, Mo. (Rochester, Pa.)
Powell, William R., 604 S. Clark St., Mexico, Mo. (Rolla, Mo.)
Rathjens, G. W., P. O. Box 175, Salt Lake City, Utah. (2182 Stanford Ave., St. Paul, Minn.)
Richardson, Gordon B., Gladding, McBean & Co., Alberhill, Calif. (621 S. Hope St., Los Angleles, Calif.)
Siegrist, Paul F., 4903 St. Elmo Ave., Chattanooga, Tenn. (2801 Hereford St., St. Louis, Mo.)
Simpson, Harold E., 87 Tibet Rd., Columbus, Ohio; Battelle Memorial Inst. (Rutgers Univ., New Brunswick, N. J.)
Starr, C. D., Rehoboth Porcelain Enamel Co., Rehoboth Village, Mass. (9 Codding St., Providence, R. I.)
Strommer, Luther T., Swindell-Dressler Corp., P. O. Box 1753, Pittsburgh, Pa. (1740 E. 12th St., Cleveland, Ohio.)
Svec, J. J., Carey, Ohio. (1304 Clinton Ave., Berwyn, Ill.)
Thompson, Robert A., 2515 Church St., Cleveland, Tenn. (4381 Balfour, Detroit, Mich.)
Vincent, Lawrence A., Swindell-Dressler Corp., P. O. Box 1753, Pittsburgh, Pa. (American Dressler Tunnel Kiln Co., Cleveland, Ohio.)
Weis, J. H., United States Feldspar Corp., Northville, N. Y. (Cranberry Creek, N. Y.)

COMMITTEE ADDITIONS AND CHANGES

Glass Division, Secretary, A. N. Finn, U. S. Bureau of Standards, Washington, D. C.
Refractories Division, Exhibit Committee, A. F. Moranty, Leeds and Northrup Co. Cleveland, Ohio.
White Wares Division, Exhibit Committee, C. C. Treischel, R. T. Vanderbilt Co., New York, N. Y.
Committee on Data, L. Navias, General Electric Co., Schenectady, N. Y.

Committee on Geology

W. M. Weigel, Chairman, Mineral Technologist, Missouri Pacific Railroad Company, 1910 Missouri Pacific Bldg., St. Louis, Mo.
Raymond B. Ladoo, United States Gypsum Co., 300 West Adams St., Chicago, Ill.
Hewitt Wilson, College of Mines, Univ. of Washington, Seattle, Wash.
John W. Whittemore, Prof. of Ceramic Eng., Virginia Polytechnic Institute, Blacksburg, Va.
G. R. Shelton, Bureau of Standards, Columbus, Ohio.

RESEARCH ADVISORY COMMITTEE, AMERICAN REFRACTORIES INSTITUTE

The Research Advisory Committee, American Refractories Institute, held a meeting in Columbus, Ohio, July 16 and 17. The members of this Committee are as follows:

J. Spotts McDowell, *Chairman*
C. E. Bales
R. P. Heuer
M. C. Booze
L. C. Hewitt
R. B. Gilmore
E. H. Van Schoick
Stuart M. Phelps, *Secretary*

GREETINGS FROM CZECHOSLOVAKIA

The members of the Czechoslovakian Ceramic Society, convened at their meeting at Moravská Ostrava, one of the industrial centers of Czechoslovakia, send your esteemed Ceramic Society their best and collegial greetings.

Signed by the officers.

P. S. Further, it was decided to express thanks to your Society and to your representatives in the celebrations of Wedgwood's Bicentenary for the support they gave to Dr. Barta's proposal in view of founding an International Ceramic Society.

LOCAL SECTION NEWS

Michigan-Northwestern Ohio Section Officers

Chairman, E. B. Flu, Champion Porcelain Co., Detroit, Mich.
Vice-Chairman, J. T. Jans, Holcroft and Co., 6545 Epworth Blvd., Detroit, Mich.
Secy.-Treas., H. M. Boardman, Champion Porcelain Co., Detroit, Mich.
Councillor, E. B. Baker, Detroit Star Grinding Wheel Co., Detroit, Mich.

Pacific-Northwest Section Officers

Chairman, Alex Corbett, Granger Clay Products, Yakima, Wash.
Vice-Chairman, P. E. Lingren, Gladding, McBean and Co., Portland, Ore.
Secretary, Hewitt Wilson, Univ. of Washington, Seattle, Wash.
Treasurer, H. O. Thompson, Builders Brick Co., Seattle, Wash.
Membership, H. O. Thompson, Phil Corbett, P. E. Lingren, and Tom Hall.
Program, P. E. Lingren, G. L. Rogers, H. Hoffmann, and Walter Howard.
Executive, for Brick and Tile, Walter Howard; for Terra Cotta and Pottery, A. B. Fosseen; for Fire Brick, G. L. Rogers; for Sewer Pipe, W. L. Lemley.
Nominations, Harry Kreitzer, Ray Smith, and A. B. Fosseen.
Councillor, S. Geijsbeek.

California Section

The regular quarterly meeting of the California Section of the AMERICAN CERAMIC SOCIETY was held on Monday, June 9, 1930, at the Engineer's Club, Los Angeles. Seventy-five members and guests were present.

Entertainment for the program was furnished by Norman W. Kelch of the Clay Products Institute, and Robert Linton of the Pacific Clay Products Co.

T. S. Curtis of the Vitrefrax Corp. gave a talk illustrated with motion pictures on "The Inside Story of Ceramics." This was the same lecture Mr. Curtis delivered at the Annual Meeting of the AMERICAN CERAMIC SOCIETY in Toronto. The talk and pictures were both very interesting and educational, and Mr. Curtis was extended a vote of thanks by those present.

NECROLOGY

Dr. J. S. Grasty, a consulting geologist living in Charlottesville, Va., passed away June 5. Dr. Grasty was a member of the AMERICAN CERAMIC SOCIETY for three years.

NOTES AND NEWS

WESTINGHOUSE SALUTE TO THE CERAMIC INDUSTRIES OVER KDKA

R. C. Purdy Talks on Ceramics

One of the oldest industries known to man is the brick and clay products industry. Out of the ground it digs its clays, and fashions them into a host of products which affect every hour of our lives. Because it is so important to the comfort and convenience of us all, and because it is an industry whose scientific research every day is finding new ways to serve us better, Westinghouse dedicated a radio salute to the Brick and Clay Products Industry, June 24, 1930.

Address by Ross C. Purdy

Industrial, structural, and household ware of clay are made to withstand the most severe electrical strains, the highest industrial temperatures, the most eroding effects of weather, or the severest corrosive action of chemicals. They also serve for permanent beautification of buildings and to satisfy the most aesthetic taste in decorations and table settings. These wide ranges of severe industrial and structural stresses, and these varied artistic demands are met by scientifically blending and fluxing together silicate minerals and metallic oxides on formulas which experience and research have determined to be requisite for each specific requirement.

The art, science, and technology of making clay products is known as ceramics.

Since glass and porcelain enamels also are made by compounding and fluxing together silicate minerals, ceramic art and science includes the producing of glass and porcelain enameled ware as well as ware made of clay.

Ceramics then may be defined as the art, science, and technology of producing usefue things by mixing and fluxing silicate minerals.

From the viewpoint of a ceramist, the crudest of brick and tile, the finest of china, porcelain, and glass, the beautiful terra cotta and tile, the kitchen enameled ware, stoves, and refrigerators, the high temperature refractories, the industrial porcelains, and abrasive wheels are all close relatives.

Each of these widely different ceramic wares is made to withstand the specific destructive conditions of its use, or made as decorative as desired by submitting it to a heat treatment sufficient to melt to a glass either a portion of the silicate mineral mixture or the entire mixture, depending upon the specific requirements which each product must meet.

Clays and shales are natural silicate mineral mixtures. Brick and tile made from

clays and shales, when well made, are more resistant to weathering influences than are the granites, and much more so than sandstone or limestone due to the glass which is formed in the kiln by firing. This glass is the bond which cements together the less easily fused mineral particles. This glass gives rigidity, strength, and the ability to withstand the destructive atmospheric influences. To this glass, which is formed in brick, is due much of the color tint which the brick attains in the firing.

Ceramics, then, is making glass from silicate mixtures. This the brick and drain tile makers do, as do the terra cotta and china ware makers, the porcelain and the abrasive wheel makers.

The glass and enamel ware makers completely melt their silicate mixtures, whereas the clay workers melt only enough of their silicate mineral mixtures to render their products sufficiently dense and strong to meet their several different requirements.

Putting glaze onto clay ware is in fact putting on a glass coating. The glazing of brick, of wall tile, of terra cotta, of pottery, or iron ware is the making of a glass on the ware.

Coloring and decorating of clay and glass ware require the same metallic oxides and the same processes.

Similar as are the fundamental principles of compounding and fixing by fire the various ceramic ware, and similar as are the fundamentals of their processing, the making of each type of ware calls for special skill and knowledge to make it resistant to the destructive agents to which it is subjected in use.

Thus it is that brickmaking is a scientific job. It cannot be done by one not informed and skilled in the art. Porcelain insulators, spark plugs, china tableware, glass and enameled ware, each require specialized skill and knowledge to produce.

Excerpts from the Westinghouse Salute to the Brick and Clay Products Industry

Brick and clay products affect every hour of our lives. Brick for houses and the facing of great buildings, brick for chimneys and for streets, porcelain for sanitary plumbing fixtures, tile that drains town and country, tile that carries millions of miles of electrical cable, and tile which supplies partitions to our great buildings. In the porcelain insulators of the spark plug, in the dishes on our table, in our pottery and in our laboratories, as in the decoration of our homes, our theaters, and our churches, the clay products industry contributes daily to the safety, comfort, and beauty of life. Without the special fire resistant brick and tile, the modern steel industry and modern research with the benefits both have brought to mankind, scarcely would be possible.

Oldest of the clay products, brick has ever been important in civilization. "Build for permanence—build with brick," said William Penn when he brought settlers to America and built for himself the first brick house in the colonies. Now, as then, homes are built of brick for beauty and permanence, great buildings are faced with it, and many a street is paved with brick to resist the wear of rumbling trucks.

Clay products have existed through the ages, identifying the progress of mankind. Yet old as the industry is, scientific research is constantly developing new and better clay products for our use, so that American clay products industries lead the world.

Electricity plays an important part in the brick and clay products industry, and Westinghouse engineers have been privileged to work closely with the industry's engineers in adapting electric power to their needs. Westinghouse motors, control, and speed reducers power the huge mills and mixers which reduce the clay to the proper fineness and mix the ingredients to the proper proportions. Westinghouse locomotives and Westinghouse equipped hoists and conveyers lighten the labor of men and speed production.

NEW INSTITUTE FOR RESEARCH

Battelle Memorial Institute of Columbus, Ohio, established by the will of Gordon Battelle, is devoted to research in metallurgy, fuels, and allied subjects. Fundamental and applied research work in these fields is conducted under a unique arrangement by which the investigators and the directors of the work are kept in close contact with both phases of research. The work of a fundamental nature is conducted by the staff and on the funds of the Institute. This work is similar to that conducted by government, state, and university laboratories and the results are to be presented before technical societies or published in technical journals. Applied research is largely carried on through industrial research projects sponsored by industries, associations, or individuals, and is carried on by the sponsors' representatives who work under the guidance and with the consultation of the Institute Staff. Results of such sponsored investigations are controlled by the sponsor and any patents resulting therefrom are his exclusive property.

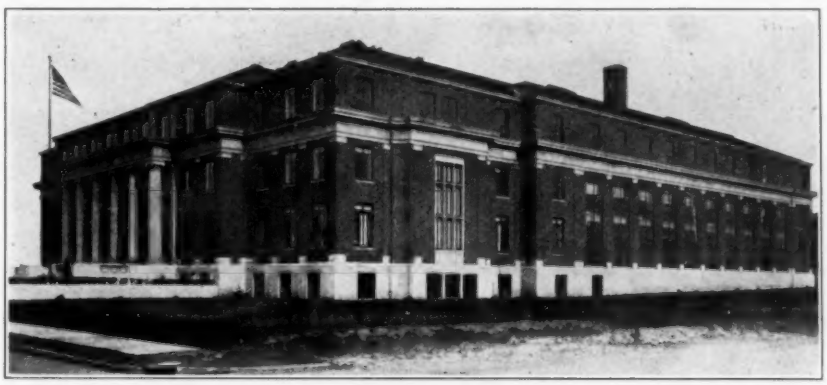

FIG. 1.—Battelle Memorial Institute.

The work on sponsored projects has the advantage of the advice and consultation of the Institute Staff and of the results of the fundamental investigations, some of which are chosen with a view that information useful to the sponsored projects may be developed.

The Institute is housed in a new building of 90,000 square feet floor space and contains offices, a large library, an auditorium, individual and general laboratories and shops, with facilities to care for 300 workers. Equipment now installed for research work of a general nature includes electric and fuel-fired melting, heat-treating, and testing furnaces, materials-testing machines, and numerous devices for making a variety of physical and chemical measurements. Equipment is being erected for making combustion and carbonization studies. Additional equipment will be added as the need for it arises.

The Institute is greatly interested in research and industrial development in the ceramic field because so many ceramic and metallurgical operations deal with high temperatures, and because refractories are so important to both the metallurgical and fuel industries. The location of the Institute in a ceramic center and the friendly reception it has received from its ceramic neighbors have heightened this interest.

As an initial undertaking in this field, the Institute is conducting a study of slagging

FIG. 2.—Library.

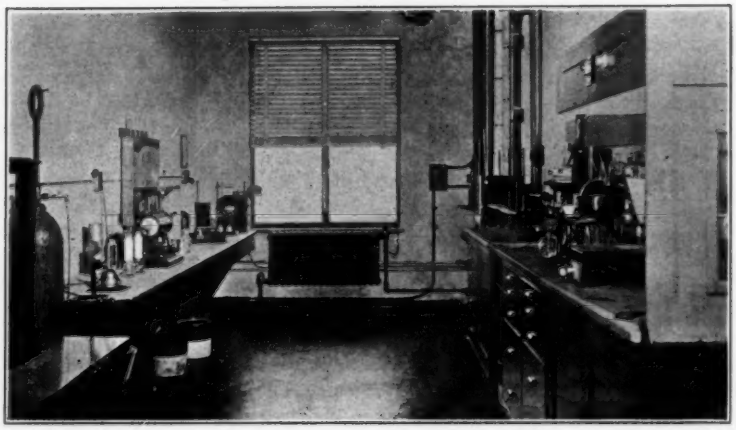

FIG. 3.—Fuel Laboratory.

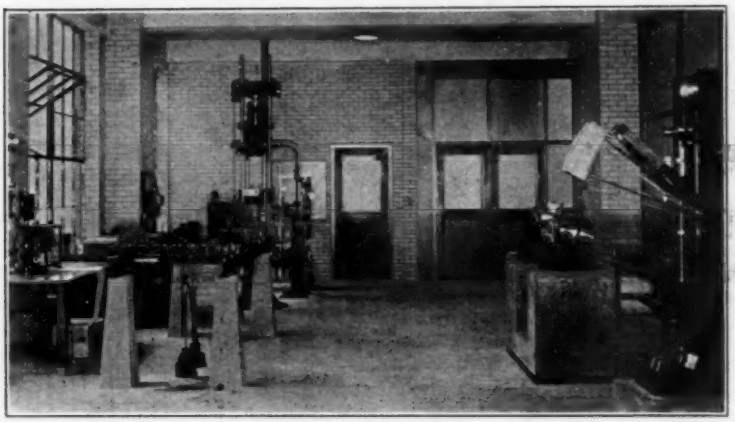

FIG. 4.—Physical Testing Laboratory.

tests of boiler refractories which is a part of the general investigation of the Special Research Committee on Boiler-Furnace Refractories of the American Society of Mechanical Engineers.

Other investigations being conducted by the Institute on its endowment funds are (1) the combustion of pulverized fuel, (2) coal carbonization, (3) the physical properties of aircraft metals and rail steel at extremely low temperatures, and (4) the beneficiation of coal and ores. In addition to these, the Institute is handling a portion of the Engineering Foundation's study of alloys of iron.

Industrial research projects are being sponsored by the following organizations: Reynolds Metals Company, Federal Mogul Corporation, Worthington Pump and Machinery

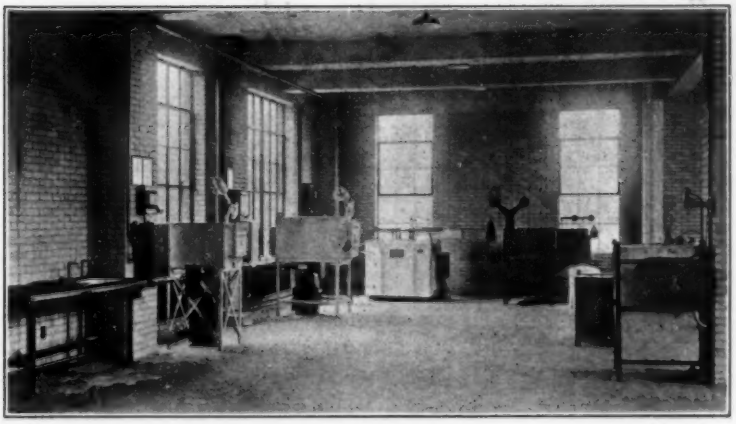

FIG. 5.—Heat Treating Laboratory.

Company, International Nickel Company, Utilities Research Commission, Wheeling Steel Company, M. A. Hanna Company, Oglebay Norton and Company, and American Rolling Mill Company. Editorial work on the publication, *Metals and Alloys* is done under the sponsorship of the Chemical Catalog Company.

FIG. 6.—H. W. Gillett, Director.

FIG. 7.—O. E. Harder, Assistant Director.

FIG. 8.—Clyde E. Williams, Assistant Director.

FIG. 9.—Ralph A. Sherman, Combustion Engineer.

The technical staff includes H. W. Gillett, Director; Clyde E. Williams, Assistant Director, Fuels, Metallurgy and Refractories; O. E. Harder, Assistant Director, Metals and Alloys; H. W. Russell, Physicist; Ralph A. Sherman, Fuel Engineer, Combustion and Refractories; Floyd B. Hobart, Fuel Chemist, Carbonization; Marjorie Benoy, Chemist; Byron M. Bird, Concentration Engineer; J. L. Gregg, Metallurgist; H. C. Cross, Metallurgist; Harold E. Simpson, Ceramic Engineer; C. H. Lorig, Metallurgist; W. A. Welcher, Mechanical Engineer; Samuel Epstein, Metallurgist; and numerous assistants.

GET ACQUAINTED WITH YOUR OWN FOLK

Mary Elizabeth Cook, Sculpturer, 1550 Clifton Avenue, Columbus, Ohio, National Arts Club, New York, N. Y.

Miss Mary Cook has been active in ceramics for several years; active in the Art Division of the AMERICAN CERAMIC SOCIETY and in ceramic affairs in Columbus. Miss Cook owns and operates a one-kiln pottery.

Miss Cook studied (1) ceramic engineering at Ohio State University, (2) sculpturing under the late Paul Wayland Bartlett, in Paris, France, (3) at Académie Collarossi, and her own studio, Paris, France, (4) anatomy at l'École des Beaux Arts, Paris, France, and (5) sketching at l'École Moderne, Paris, France.

Miss Cook is a member of (1) Société Internationale des Beaux-Arts et de Lettres, Paris, France, (2) The National Sculpture Society, New York, (3) National Arts Club, New York, (4) College Art Assn. (New York University) of America, (5) Art Alliance-Art Center, New York, (6) The American Artist's Professional League, New York, (7) National Assn. Women Painters and Sculptors, New York, (8) Art Alliance of Philadelphia, (9) American Federation of Arts, Washington, D. C.,

FIG. 1.—Memorial panel in bronze of Joseph Andrew Jeffrey in lobby of Jeffrey Mfg. Co., Columbus, Ohio.

FIG. 2.—Garden statue in kasota stone.

(10) Society of Medalists, Washington, D. C., (11) AMERICAN CERAMIC SOCIETY, (12) Art League, Columbus, Ohio, (13) Gallery of Fine Arts, Columbus, Ohio.

The more important of Miss Cook's exhibitions were made at (1) Spring Salon, Paris, (2) International Painters and Sculptors Exhibit, Paris, (3) National Sculpture Society, New York and Brooklyn, (4) National Assn. Women Painters and Sculptors, New York, (5) Architectural League, New York, (6) Albright Gallery, Buffalo, (7) Outdoor Sculpture Exhibition, National Sculpture Society, San Francisco, Calif. (April 1 to September 30, 1929), (8) Pennsylvania Academy, Philadelphia, (9) Art

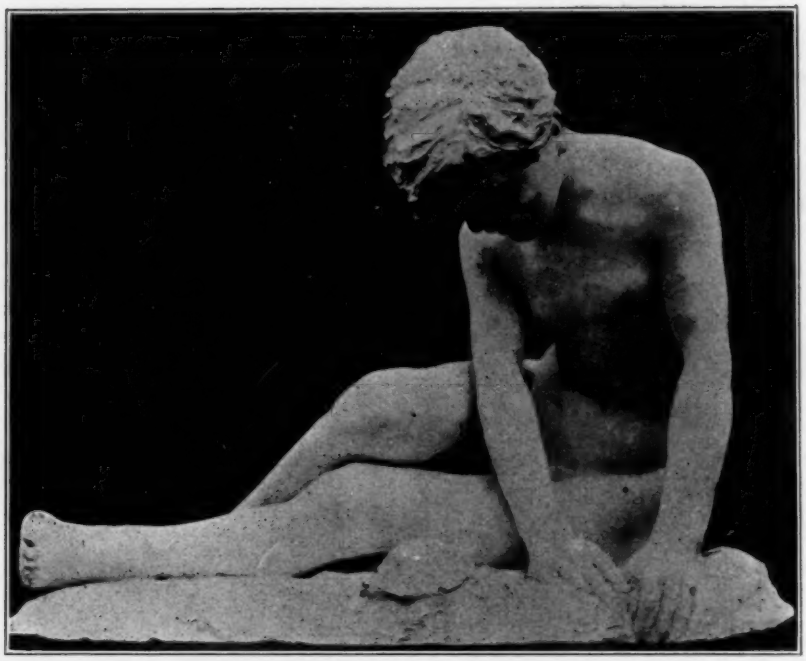

FIG. 3.—Garden statue in marble. Exhibited in Spring Salon, Paris.

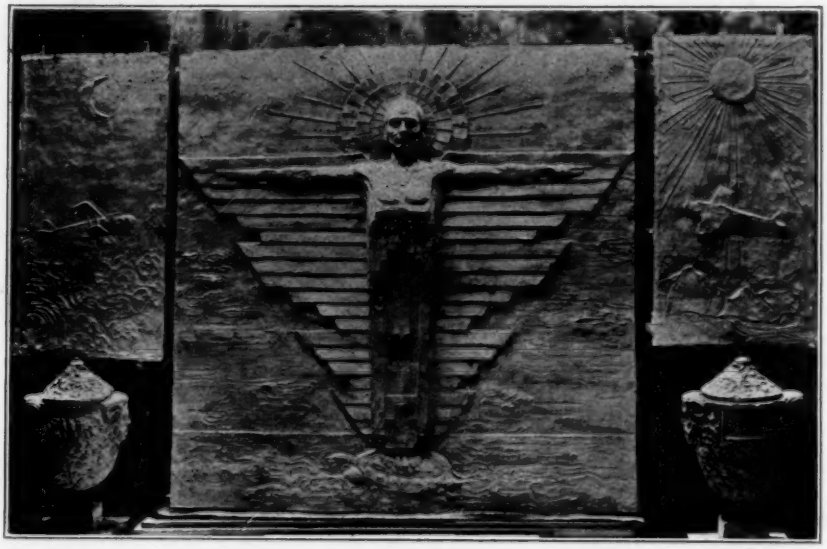

FIG. 4.—One of series of symbolic panels, "Aviation." The oriental idea of the great sea turtle that disturbed the waters of the globe until man's creative thought appeared as symbolized in winged figure and aviation in this era.

Alliance, Philadelphia, (10) Plastic Club, Philadelphia, (11) American Federation of Arts, Washington, D. C., (12) Smithsonian Museum, Washington, D. C., (13) Toledo Museum, Toledo, Ohio, (14) Gainesville (State University), Florida, (15) Columbus Gallery of Fine Arts, Columbus, Ohio, (16) League of Columbus Artists, Columbus, Ohio.

Some of Miss Cook's more important works are to be found in New York, N. Y., (*a*) Bronze garden statue, and (*b*) Marble portrait.

Washington, D. C. (*a*) Gothic arch in glazes and lustered terra cotta and (*b*) Medi-

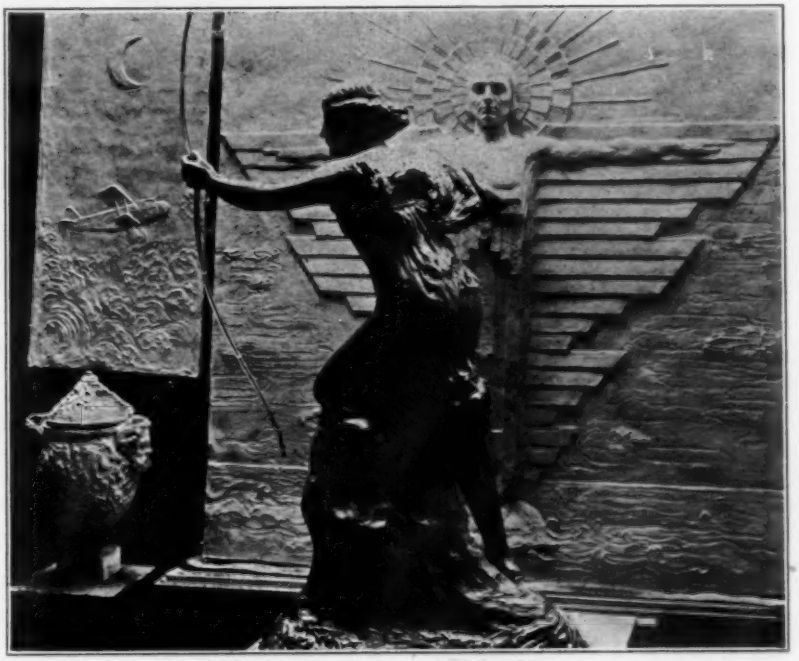

FIG. 5.—"Diana," garden statue. Designed, modeled and fired in kiln in her own studio.

cal Museum of the Smithsonian, War Work. Models in wax showing reconstruction of faces of soldie s for which work life masks and models for bone and skin grafts were made as follows: Life masks, 500. Models for bone and skin grafts, 600. Drawings and water colors from life. Four years service volunteered.

Los Angeles, Marble group.

Colorado Springs, Memorial in terra cotta.

St. Louis, Memorial fountain in glazed terra cotta.

Arizona, Terra cotta bas reliefs, urns, etc.

Columbus (*a*) Exterior and interior terra cotta, residence of Mr. and Mrs. Edward N. Huggins, (*b*) "Diana," terra cotta garden statue, General and Mrs. Edward Orton, Jr., (*c*) Memorial in stone, Broad Street Presbyterian Church, (*d*) Ohio State University, marble drinking fountain over mantel panel, (*e*) Portrait in marble of Joseph A. Jeffrey,

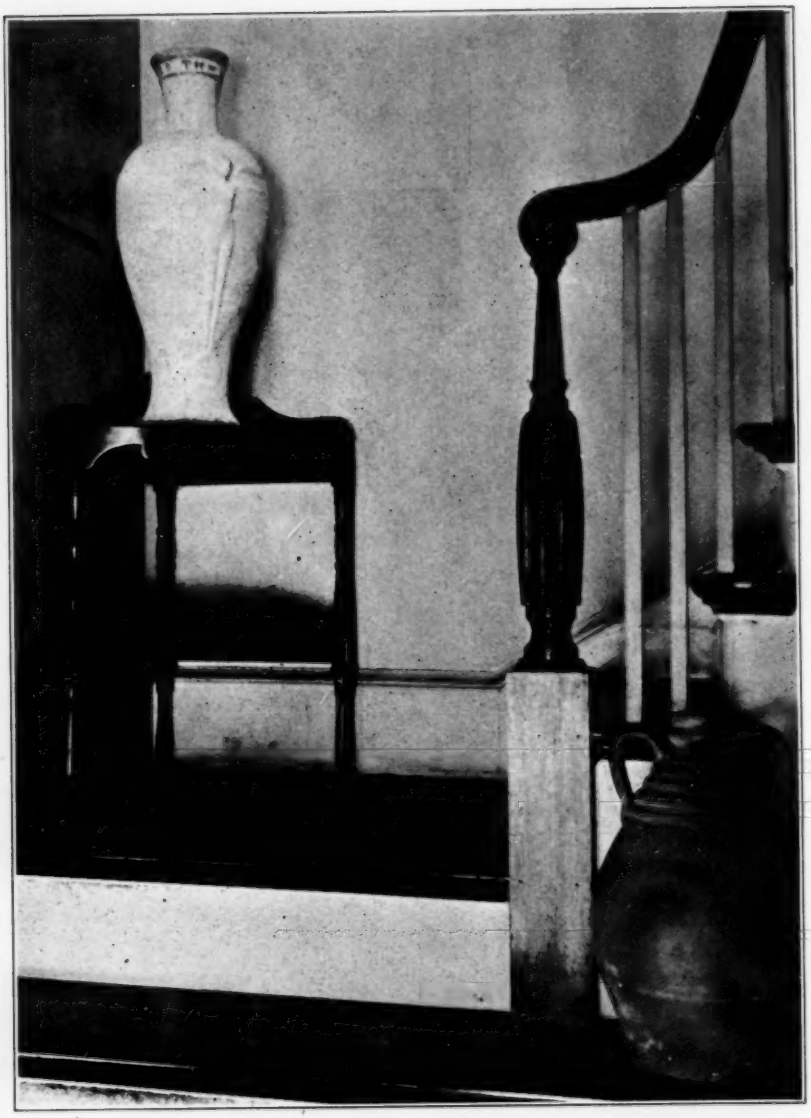

FIG. 6.—Terra cotta vase.

FIG. 7.—Gothic arch in enameled and lustered terra cotta. Colors are blue, white, old buff, copper luster, and black luster. Designed, modeled, and fired by Mary E. Cook.

FIG. 8.—Bronze garden statue.

FIG. 9.—Portrait in marble.

(*f*) Portrait in bronze of Joseph A. Jeffrey, (*g*) Portrait in bronze of Starling Loving, (*h*) Portrait in terra cotta of Elizabeth Crotti, (*i*) Portrait in marble, "Betty," (*j*) Statue in kasota stone, garden of Mr. and Mrs. Claude Meeker, (*k*) Sun dial in terra cotta, garden of Mr. and Mrs. E. M. Poston, (*l*) Bronze fountain figure, garden of Mr. and Mrs. Walter Martin, (*m*) Bronze fountain figure, garden of Mr. and Mrs. Emile E. Watson, (*n*) Lunette over door; caryatides in coen stone, models for Renaissance carving over mantel, residence of F. A. Howald, (*o*) Garden urns, Mr. and Mrs. O. A. Miller, (*p*) Children's Hospital, memorial portrait in marble, Mrs. James Kilbourne, marble and terra cotta fountain, bas reliefs in glazed terra cotta, two marble seats, (*q*) Portrait of Henry Gilbert (bronze), Gilbertsville, N. Y., (*r*) Memorial fountain in marble and bronze, in plaza of Public Library, presented to the city by Charles E. Munson, (*s*) Bronze fountain, garden of Mr. and Mrs. O. C. Altmaier, and (*t*) Memorial panel (bronze) of Joseph A. Jeffrey.

FIG. 10.—Portrait of Dr. Hartmann in marble.

R. M. KING VISITS IN U.S.S.R.

The accompanying photograph was received recently from P. P. Budnikoff of Charkoff, Ukrainia, U.S.S.R. R. M. King and Mrs. King, both of the faculty of

First row, P. P. Budnikoff, Mrs. R. M. King, Mr. Kruse, R. M. King, S. I. Perkal. Second row, Mr. Losinsky, W. J. Endowitsky.

Ohio State University have been traveling in Europe since May, having attended the celebration of the Wedgwood Bicentenary in England. At Charkoff they visited Prof. Budnikoff at his Laboratory of Ceramic Technology, Technological Institute.

GLASS CONTAINER INDUSTRY WINS ART RECOGNITION

Samples of Owens-Illinois Modern Products Are Displayed in One of World's Leading Art Museums

The exhibit of modern products of the Owens-Illinois Glass Company now being presented in the Toledo Museum of Art, one of the most famous art institutions in the world, is viewed by leaders in the glass industry as a significant tribute to the new position that has been won in the glass container field by combining artistic design with practicability.

The Owens-Illinois exhibit in the art institution, which is visited annually by thousands of persons from all sections of the globe, clearly illustrates the remarkable adaptation of art in the modern glass container. It is pointed out that the interest of such an art organization in a commercial product elevates that product from the ordinary to a place of distinction.

The exhibit is striking proof that even in such articles as glass containers, it is possible to apply the artistic without sacrificing the practical uses for which the articles

are intended, and means that the incorporation of art in the design of the modern glass container is now permanently established.

This revolutionary step is the result of the installation of a highly efficient design department as one of the new important divisions within the Owens-Illinois organization.

These designers state that their eventual development of a new design is not merely a happen-so, but is based on practical research work and the application of artistic touches to fit.

As a matter of fact, the design of these modern products really embraces the fundamentals of art which originated as far back as 600 B.C. It might be hard for one to really imagine that the design of a new catsup bottle, pickle or fruit jars, exquisite

FIG. 1.—These are a few of the many designs created by the Design Department of the Owens-Illinois Glass Company, Toledo, Ohio.

perfume and toilet water bottles, or a wide variety of beverage bottles is based on the theory of proportion and design evolved centuries ago by the Egyptians and Greeks. Yet such is the case, for the very keynotes of modern art may easily be traced to simplicity of line and decoration, the underlying feeling of motion and the proportionate beauty of form of the ancient art plan of the Greeks and Egyptians.

A careful study of the Owens-Illinois design department reveals that its designers have gone into a detailed study of the ancient methods of design and as a result have incorporated those fundamentals characteristic of the ancient masterpieces.

By incorporating art with practicability in design these designers have lifted a wide variety of containers from the conventional type and have given them a sense of dignity and refreshing eye appeal.

Before launching into the work of developing a design, in order that practicability is assured, the stylist or designer, from the results of research work, knows exactly the manufacturing limits under which he must work, the use to which the container is to

be put, the variety of machine operations necessary in labeling, sealing, capping, etc. With this information at hand he is thoroughly equipped to proceed with a design that will fully meet modern demands in every phase.

The unusual interest that is being shown by hundreds of art students in the Owens-Illinois museum exhibit is a clear indication of a new position of merit in the advance-

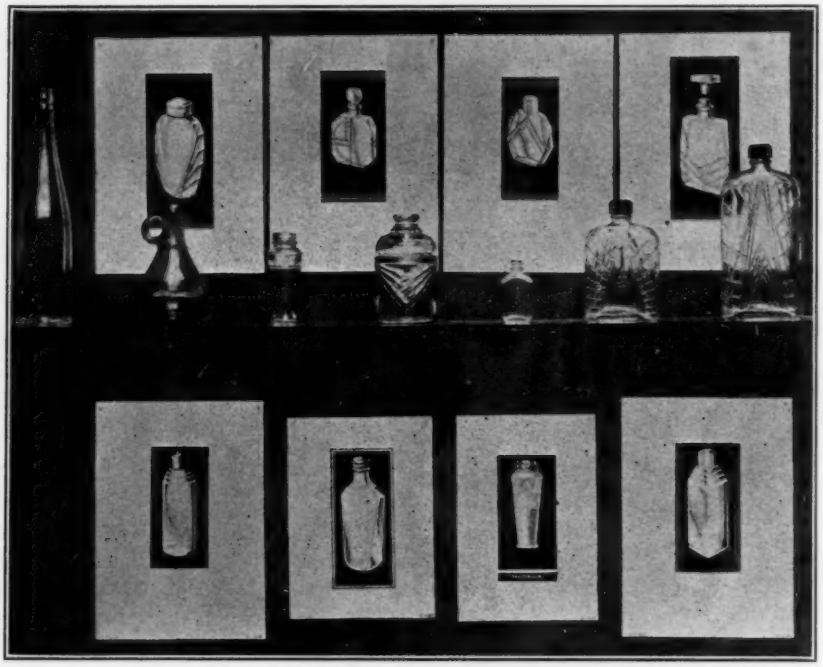

FIG. 2.—This shows a portion of the Owens-Illinois glass exhibit in the Toledo Museum of Art, one of the most prominent art institutions in the world. It shows the application of artistic design in every-day containers.

ment of the glass container industry and is said by well informed persons to mark an epochal step. It means that no longer will the glass container manufacturer follow past practices of taking the lines of least resistance as he did in many cases, using a conventional design for containers intended for specific uses. With the now accepted entry of modern art in glass container design, it will be the aim of the glass manufacturer to follow the modern trend successfully inaugurated by Owens-Illinois and incorporate art in his design insofar as it is possible with due regard for limitations.

CERAMIC SCHOOL NOTE

Development of Ceramics at the University of Alabama

Courses in ceramics were first established in September, 1928, with T. N. McVay in charge of the work. The Department of Chemistry and Metallurgy was expanded

in 1929 into the School of Chemistry, Metallurgy, and Ceramics with Stewart J. Lloyd as Dean. A curriculum leading to the degree of Bachelor of Science has been established with twenty-five registered in the School. A much larger enrolment is expected for next year. The course of study has also been revised so that all students registered in chemical engineering are required to take basic courses in ceramics.

A considerable amount of new equipment has been assembled in the laboratories. This equipment consists of clay washing and blunging apparatus, driers heated with gas and electricity, pebble mills, dry press, Mueller roll press, jaw crusher, pulverizer, and silicon-carbide cutting wheel. A large gas-fired test kiln has been built which is equipped with Maxon Premix burners and is capable of reaching at least cone 18. An air compressor has been installed which furnishes air for a cone fusion furnace, a small test kiln, and for a frit furnace, and compressed air is thus available for spraying glazes and enamels. A three-point automatic recorder has been furnished by the Brown Instrument Co. Other equipment such as a complete set of standard sieves, psychrometer, draft gage, Orsat apparatus, and portable potentiometer has been purchased.

Sixty students have been registered in the various courses which have been offered.

The Ceramic Department has assisted the Department of Fine Arts in firing the ware made by that department and glazes suitable for local clays have been developed. Two students have been engaged in testing clays collected by the State Geological Survey and another student has done considerable work on refractory mixes of silicon carbide and fused alumina. A coöperative investigation of ceramic bonds for grinding wheels is now under way. This is a joint investigation being conducted by Samuel Rusoff, Sterling Grinding Wheel Co., Tiffin, Ohio, A. B. Peck, University of Michigan, The Federal Abrasives Co., Anniston, Alabama, and the Ceramic Department of the University of Alabama. Considerable testing and research work has been done for several manufacturers of the state. Wherever possible, it is the policy of the department to encourage students to work on practical problems which will be of value to the industry and routine laboratory work is reduced to the minimum.

H. L. Cullen who received his degree in Chemical Engineering this June is now employed by the Harbison-Walker Refractories Co. at its Bessemer, Alabama, plant.

CORRECT USE OF THE TRADE-MARK "PYREX"

The Corning Glass Works of Corning, New York, is waging an active campaign against the tendency on the part of authors and the general public to treat their trade-mark "Pyrex" as a common generic noun. "Pyrex" is a trade-mark of Corning Glass Works, registered in the United States and many foreign countries and is applied to a series of resistant glasses from which such articles of ware as baking ware, insulators, front glasses for light projectors, laboratory ware such as test tubes, beakers, flasks, dessicators, etc., industrial ware, and many other products are made. These products are all sold under the "Pyrex" trade-mark and in many instances glass compositions will vary to suit the particular service for which the article is intended so that it immediately becomes apparent that "Pyrex" is not the name of a material but is the trade-mark under which a number of resistant glasses having differing characteristics are sold. The proper name of the material from which "Pyrex" articles are made is "resistant glass" and wherever the word "Pyrex" is employed it should always begin with a capital letter and be put in quotation marks to denote the fact that it is a trade-mark and not a common noun.

AMERICAN STANDARDS YEAR BOOK LISTS STANDARDIZATION DEVELOPMENTS AFFECTING MAJOR INDUSTRIES[1]

Cortelyou Sees Standardization Cutting Seasonal Unemployment

Important progress in standardization work affecting mechanical, electrical, railways, mining, and other major American industries is reported in the American Standards Year Book for 1930, just published by the American Standards Association.

George B. Cortelyou, President of the Consolidated Gas Company of New York, in a foreword to the Year Book says:

Standardization is of prime importance at the present time to practically every American industry as a means of promoting industrial stabilization and of minimizing unemployment.

It permits the continuous production of products and parts, during periods of slackened buying, in anticipation of future demand. For the same reason, it makes for steady employment of labor. It broadens markets nationally, and even internationally.

As a principal means of introducing improvements in design and economies in production and distribution, it furthers the sound development of industries and helps to open potential markets. On these grounds alone it merits sympathetic study on the part of every business executive.

Among the high spots of the standardization movement during the past twelve months the Year Book notes:

The underwriting by industry of $500,000 for the promotion of national standardization during the next three years.

The affiliation of the American Standards Association with the national standardizing bodies of twenty other nations, through the International Standards Association. This body, which has its headquarters at Zurich, Switzerland, will promote international coöperation in standardization work.

Increased recognition of the value of national industrial standards in the field of foreign trade.

The completion of an agreement between the American Standards Association and the U. S. Bureau of Standards providing for a maximum degree of coöperation between the government and private bodies in the promotion of industrial standardization.

William J. Serrill, President of the American Standards Association, in his report on developments of the past year, lists the following organizations which have become member-bodies of the A. S. A. during that period:

American Home Economics Assn.
Common Brick Manufacturers' Assn. of America
Drill and Reamer Society
Laundryowners National Association of the United States and Canada
Milling Cutter Institute
National Assn. of Mutual Casualty Companies
National Bureau of Casualty and Surety Underwriters
National Coal Assn.
National Safety Council
Tap and Die Institute

The membership of the Association now includes 43 national technical societies, trade associations, and governmental bodies. The Association has, up to the present time, approved 166 national industrial standards, and projects for 171 other standards are under way.

In his review of the underwriting of A.S.A. finances for the next three years, Mr.

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[1] Copies of the American Standards Year Book may be obtained free of charge by writing to the American Standards Association, 29 West 39th St., New York, N. Y.

Serrill lists the following companies as contributing to the underwriting which is intended to provide $150,000 per year for the work of the Association:

Aluminum Company of America
American Telephone and Telegraph Company
Bethlehem Steel Company
Consolidated Gas Company
Detroit Edison Company
Ford Motor Company
General Electric Company
General Motors Corporation
Gulf Oil Company
Public Service Corporation of N. J.
Standard Oil Company of N. J.
U. S. Steel Corporation
Westinghouse Elec. and Mfg. Co.
Youngstown Sheet and Tube Company

The American Railways Association has also joined in the underwriting to the extent of $15,000 per year for the three-year period.

In the Association's major field of activity, the establishment of standards and specifications, important activity may be recorded. It will be recalled that under the revised procedure of the A.S.A. four methods of work are provided. Projects are now going forward under all of these methods.

The new standards approved during the past year include important mechanical standards, such as tool holder shanks and tool post openings. In the electrical field, in addition to the standard for outlet boxes, there is a new standard of regulations for electric wiring and apparatus in relation to fire hazard, the code for protection against lightning, the first national standard for radio, fixing the dimensions governing fit of four-pin vacuum tube bases, and the arrangement of terminals. The railroad industry is represented by a new standard for materials for use in the manufacture of special track work. Of interest to almost all engineers is the new standard for symbols for hydraulics, aeronautics, for electrical quantities, and for telephone and telegraph use.

The new projects initiated during 1929 include such subjects as annular ball bearing, methods of laboratory sampling and analyses of coal and coke, standardization of Diesel fuel oils, specifications for coal mine cars and for mine timbering, locomotives for coal mines, graphical symbols used in radio communication, and general methods of testing woven textile fabrics.

To render the preparation of national standards in the major industrial fields more effective, correlating committees have been organized in some of these fields. There are now, for example, electrical, mining, and safety correlating committees. Efforts have been under way for some time to complete the organization of a similar committee in the mechanical field. It will be most advantageous if this can be completed and brought to the point of becoming an actively functioning body at the earliest possible moment.

There has been a very rapid growth of the A.S.A. Information Service during 1929. Hundreds of foreign standards, new and old, have been loaned to American manufacturers and trade associations. During the year the Information Service was able to take care of over thirteen hundred requests for information concerning standards and standardization; about one thousand publications relating to standards and standardization, including five hundred new foreign standards, were added to the Association files.

ENGINEERING EXPERIMENT STATION MEASURE PROGRESSES[1]

Bill Reported Favorably by House Agriculture Committee

The proposal to give coöperative Federal aid to engineering experiment stations and land grant colleges, has made considerable progress during the present session of Congress. In all, there have been five bills introduced on this subject. Senator McNary

[1] Reprinted from American Engineering Council, *Bulletin*, June, 1930.

introduced S. 696; Congressman Arentz, H. R. 7831; and Congressman Haugen, H. R. 9717. After extensive hearings and investigations, the best thought of all these bills was incorporated in two measures, H. R. 11789, by Haugen, and S. 4172, by McNary. These latter two bills, identical in substance, are enthusiastically supported by the friends of this legislation.

H. R. 11789 Reported

The House bill was reported favorably by the Committee on Agriculture, April 22, Report No. 1259, and is now on the calendar in the House. The committee, however, has had the last calendar call it will probably have this session of Congress, and efforts to obtain a special rule under which this measure may be considered, have been unsuccessful, due to the crowded condition of the legislative calendar and the desire of Congress for early adjournment. It is believed that the thorough investigation and educational work done in behalf of this measure insure its enactment in the next session of Congress.

Provisions of the Measure

The pending bill proposes that the United States Government contribute $10,000 in 1932, $15,000 in 1933, $20,000 in 1934, and $25,000 for each fiscal year thereafter, to each State and Territory in which an operating engineering experiment station is maintained by a land grant college. In the event that a State is not maintaining an engineering experiment station, it is given three years in which to establish and organize one. A State must also provide, for every dollar contributed by the Federal Government, at least $3 for like periods and purposes, exclusive of land, buildings, and equipment. The measure makes the following provision:

That the funds appropriated pursuant to this act shall be applied only to paying the necessary expenses of conducting investigations and experiments by said engineering experiment stations bearing directly on the development of engineering principles and technique in relation to agriculture and the mechanic arts, including transportation; on the introduction of engineering procedure and management; on the utilization of power resources; on the development and application of machinery and equipment in economizing production; on the utilization of agricultural products and of agricultural and trade and industrial wastes; on the engineering features of production, sanitation, and public resources, domain and safety; and such other investigations as relate to the establishment and maintenance of permanent and efficient mechanic arts industries, and the improvement of the homes and lives of the people engaged therein; and for printing and disseminating the results of said investigations, experiments, and researches. It shall be the duty of said engineering experiment stations to correlate their investigations and researches, provided for herein, avoiding unnecessary duplication, and to coöperate with the various departments and agencies of the Federal Government engaged in engineering work. Such correlation and coöperation are hereby authorized and directed, and shall be promoted and required by the Secretary of Agriculture in researches related to agriculture and by the Secretary of Commerce in other researches.

Ample supervision and checks to prevent duplication and to insure coördination of the work, are provided in Section 5 which reads:

That the Secretary of Agriculture shall ascertain and certify annually to the Secretary of the Treasury as to each State and Territory whether it is complying with the provisions of this Act and is entitled to receive its share of the annual appropriation for engineering experiment stations under this Act. If the Secretary of Agriculture shall permanently withhold from any State or Territory a certificate for all or any part of its appropriation, the facts and reasons therefor shall be reported to the President, and the amount involved shall be kept separate in the Treasury until the close of the next Congress in order that the State may, if it shall so desire, appeal to Congress from the determination of the Secretary of Agriculture. If the next Congress shall not direct such sum to be paid it shall be covered into the Treasury. The Secretary of Agriculture is hereby charged with the proper administration of this Act, with the co-

operation of the Secretary of Commerce and of the respective heads of the other Federal departments and agencies engaged in specialized branches of engineering and of other phases of the mechanic arts.

INTERNATIONAL MUSEUM OF CERAMICS

Royal School of Ceramics, Faenza, Italy

The exhibit of glazed ceramics and glossy metal ware obtained from excavations in Egypt, completed at the Museum of Ceramics at Faenza by the noted orientalist, F. R. Martin of Stockholm, with illustrative and documentary treatise of the classical origin of this particular branch of ceramics, has caused great interest among scholars. It has been visited by the specialist Bernard Rackham of the Victoria and Albert Museum of London, H. C. Gallois of the Hague Museum, R. L. Hobson of the British Museum in London, Friedrich Sarre of the Kunstgewerbe Museum in Berlin, etc. The directors of the Museum and F. R. Martin have decided to extend the time of the exhibit during all of October, 1930. Aside from this, June, 1930, will see the inauguration of the third course in the history of Italian medieval and modern ceramics, a display of polychrome Mohammedan ceramics, with works of "the master of wild animals," etc.

CALENDAR OF CONVENTIONS

Organization	Date	Place
American Assn. for the Advancement of Science	December 29, 1930 to January 3, 1931	Cleveland, Ohio
AMERICAN CERAMIC SOCIETY	February 22–28, 1931	Cleveland, Ohio
American Chemical Society	September 8–12	Cincinnati, Ohio
American Concrete Institute	February, 1931	Milwaukee, Wis.
American Electrochemical Society	September 25–27	Detroit, Mich.
American Engineering Council	October	Washington, D. C.
American Gas Assn.	October 13–17	Atlantic City, N. J.
American Institute of Mining and Metallurgical Engineers	September 11–13	Pittsburgh, Pa.
American Mining Congress		
Western Division Meeting	October 13–18	El Paso, Texas
Annual Convention	December 1–6	Washington, D. C.
American Refractories Institute	October	Atlantic City, N. J.
American Society of Mechanical Engineers	October 13–15	French Lick Springs, Ind.
American Society for Steel Treating	September 22	Chicago, Ill.
American Society for Testing Materials	June 22–26, 1931	Chicago, Ill.
American Standards Assn.	September, 1930	New York, N. Y.
Eastern Clay Products Assn.	August 12	Pittsburgh, Pa.
Feldspar Grinders' Institute, Inc.	September 27	Spruce Pine, N. C.
Grinding Wheel Mfrs. Assn. of U. S. and Canada	September 19	Shawnee on Delaware, Pa.
Gypsum Assn.	September 9	Chicago, Ill.
Illuminating Engineering Society	October 7–10	Richmond, Va.
Mining and Metallurgical Society of America	September	New York, N. Y.
National Academy of Sciences	September 18–23	Berkeley, Palo Alto, and Pasadena, Calif.

National Assn. of Mfrs. of Heating and Cooking Appliances	May, 1931	New York, N. Y.
National Electrical Exposition	October 6–11	New York, N. Y.
National Exposition of Power and Mechanical Engineering	December 1–6	New York, N. Y.
National Glass Distributors Assn.	December 2–4	Pittsburgh, Pa.
National Safety Council	Sept. 29 to Oct. 4	Pittsburgh, Pa.
New Jersey Clay Workers Assn.	December	New Brunswick, N. J.
Optical Society of America	October	Charlottesville, Va.
Taylor Society, Inc.	December 3–5	New York, N. Y.
Tile & Mantel Contractors' Assn. of America, Inc.	April 14–17, 1931	Milwaukee, Wis.
Western Canada Brick & Tile Assn.	December	Saskatoon, Sask.
Wisconsin Clay Product Mfrs.	October	Madison, Wis.

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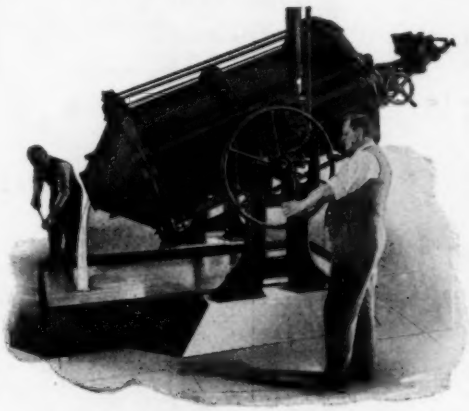

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Roessler & Hasslacher Chemical Co.

Barytes
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Borax Glass
Harshaw Chemical Co.
Pacific Coast Borax Co.

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Hommel, O., Co.
Pacific Coast Borax Co.

Boric Acid (Crystal, Granular or Powder)
American Potash & Chemical Co.
Drakenfeld & Co., B. F.
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Hommel, O., Co.
Pacific Coast Borax Co.

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C

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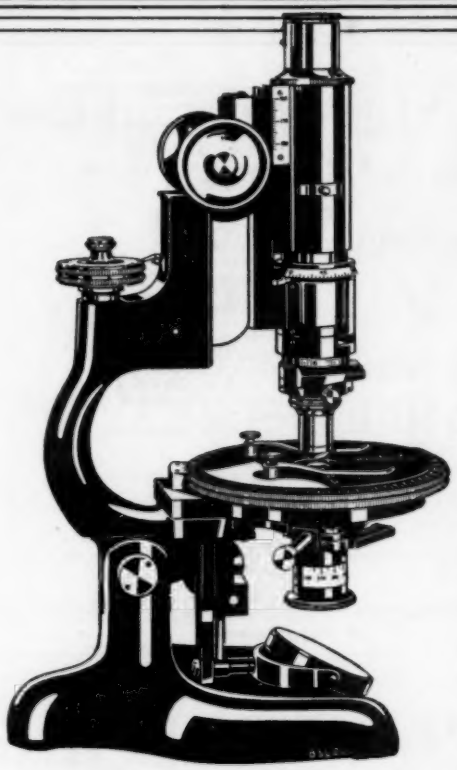

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Spinks Clay Co., H. C.
United Clay Mines Corp.

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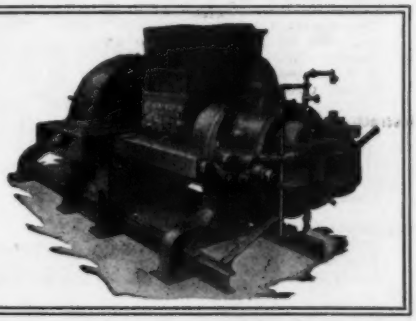

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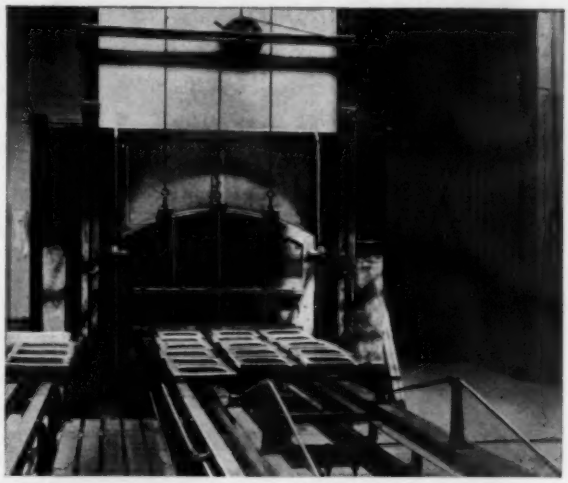

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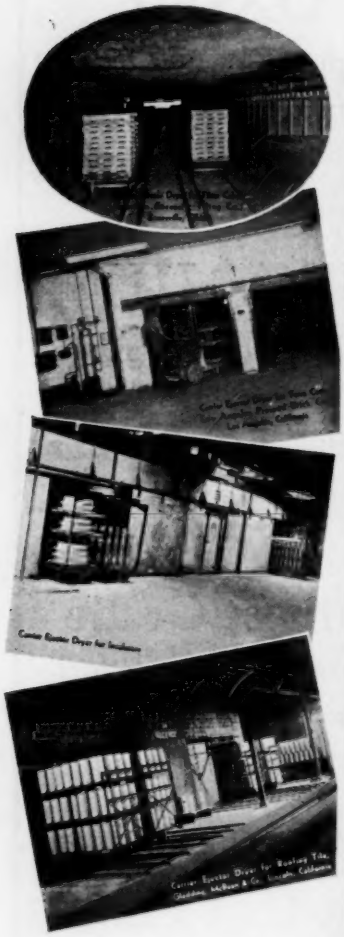

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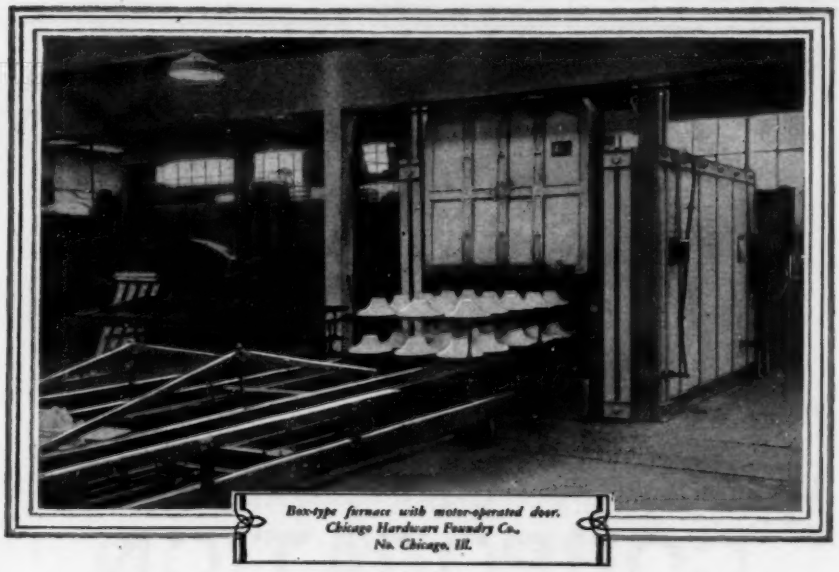

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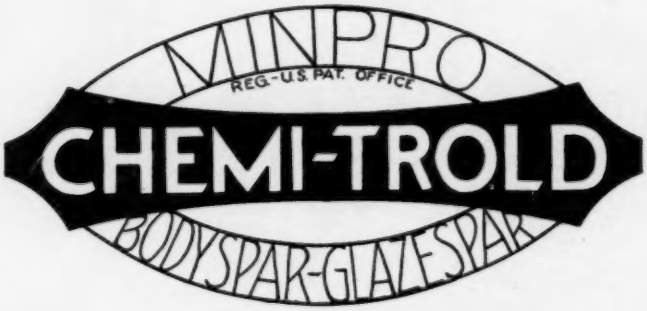

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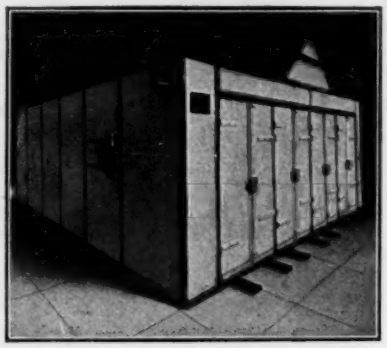

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